Department of Defense
Fiscal Year (FY) 2021 Budget Estimates

February 2020

Army

Justification Book of

Research, Development, Test & Evaluation, Army

RDT&E − Volume I, Budget Activity 2

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UNCLASSIFIED
RESEARCH, DEVELOPMENT, TEST AND EVALUATION, ARMY
APPROPRIATION LANGUAGE

For expenses necessary for basic and applied scientific research, development, test and evaluation, including maintenance, rehabilitation, lease, and operation of facilities and equipment, $12,770,165,000.00 to remain available for obligation until September 30, 2022.

COST STATEMENT

The following Justification Books were prepared at a cost of $460,861: Aircraft (ACFT), Missiles (MSLS), Weapons & Tracked Combat Vehicles (WTCV), Ammunition (AMMO), Other Procurement Army (OPA) 1 – Tactical & Support Vehicles, Other Procurement Army (OPA) 2 – Communications & Electronics, Other Procurement Army (OPA) 3 & 4 - Other Support Equipment & Spares, Research, Development, Test and Evaluation (RDTE) for: Budget Activity 1, Budget Activity 2, Budget Activity 3, Budget Activity 4, Budget Activity 5A, Budget Activity 5B, Budget Activity 5C, Budget Activity 6, Budget Activity 7, and Budget Activity 8.

UNCLASSIFIED
FY 2021 RDT&E, ARMY PROGRAM ELEMENT DESCRIPTIVE SUMMARIES
Introduction and Explanation of Contents

1. General. The purpose of this document is to provide summary information concerning the Research, Development, Test and Evaluation, Army program. The descriptive summaries are comprised of R-2 (Army RDT&E Budget Item Justification – program element level), R-2A (Army RDT&E Budget Item Justification – project level), R-3 (Army RDT&E Cost Analysis), R-4 (Schedule Profile Detail) and R-5 (Termination Liability Funding for MDAPs) Exhibits, which provide narrative information on all RDT&E program elements and projects through FY 2020.

2. Relationship of the FY 2021 Budget Submitted to Congress to the FY 2020 Budget Submitted to Congress. This paragraph provides a list of program elements/projects that are major new starts, restructures, developmental transitions, and terminated programs. Explanations for these changes can be found in the narrative sections of the Program Element R-2A Exhibits.

New Start Programs:

Budget Activity	***OSDPE / Project***	***Project Title***
02	0602115A / EB2	HIV Biomedical Technology
02	0602134A / CD2	Counter Improvised-Threat Advanced Studies
02	0602146A / AQ2	EW Techniques Technology
02	0602146A / AQ7	High Tempo Data Driven Decision Tools Technology
03	0603002A / MP3	Phys Chem Toxicity Assessment Sys Adv Tech
03	0603115A / EB3	HIV Medical Development
03	0603134A / CD3	Counter Improvised-Threat Simulation
03	0603463A / AQ8	High Tempo Data Driven Decision Tools Adv Tech
03	0603463A / AR8	Sensing in Contested Environments Adv Tech
03	0603463A / AU2	Optimization of Geospatial Data for Visualization
03	0603463A / AV1	GEOInt/Ops Logistics Integration-Planning Adv Tech
03	0603463A / AW6	Modular GPS Independent Sensors Advanced Tech
03	0603920A / CD5	Humanitarian Demining
04	0603804A / EW8	Armored Engineer Vehicles
04	0604115A / AX3	Technology Maturation Initiatives

04	0604134A / CD4	Counter Improvised-Threat Demonstration
05	0304270A / FJ5	Terrestrial Layer System (MIP)
05	0604601A / S64	Common Remotely Operated Wpn Sys (CROWS)
05	0604604A / BX8	Cold Weather All-Terrain Vehicle (CATV)
05	0604622A / E50	TRAILER DEVELOPMENT
05	0604802A / XT2	40mm Door Breach
05	0605145A / CD6	Medical Products and Support Systems Development
06	0605801A / M23	US Army Corps of Engineers Base Operations
06	0606105A / CD7	Medical Program-Wide Activities
07	0203802A / VV2	TOW
07	0607145A / FD5	Apache Product Improvement
07	0203802A / VT9	Lethal Miniature Aerial Missile System (LMAMS)

Program Element/Project Restructures:

Budget Activity	***Old OSDPE / Project: Title***	***New OSDPE / Project***
02	0602141A / AH5: Projectile and Multi-Function Warhead Technologies	0602143A/AY6, 0602145A/BK5
02	0602143A / AN1: Narrowband SATCOM Technology	0602146A/BZ6, 060346A/AN2
02	0602143A / BE1: Support Technology to Mission Command	0602146A/AQ9
02	0602144A / BL4: Countermine Technology	0602145A/BF9
02	0602145A / BH2: C4ISR Modular Autonomy Technology	0602145A/BF9
02	0602145A / BH7: Enhanced VETRONICS Technology	0602145A/BH5
02	0602145A / BJ3: Hydrogen Based Combat System Technology	0602145A/BH5
02	0602145A / BJ7: Detection of Explosive Hazards Technology	0602145A/BF9
02	0602146A / AN3: Non Traditional Waveforms Technology	0603463A/AP6
02	0602146A / AV7: Atmospheric Modeling and Meterological Technology	0603772A/101
02	0602147A / AF5: Simulation and Aerostructures Technology	0602147A/AE7
02	0602147A / AF6: Structures Technology	0602147A/AE7
02	0602147A / AF7: Warhead Integration Technology	0602147A/AE7

02	0602147A / AF9: Precision and Accuracy Technology	0602147A/AE7
02	0602147A / AG1: Missile Electronics Technology	0602147A/AE7
02	0602147A / AG2: Information and Signal Processing Technology	0602147A/AE7
02	0602147A / AG8: Advanced Energetics Technology	0602141A/AH9
02	0602147A / AG9: Multiple Simul Engagement Technologies (MSET) Tech	0602148A/AK4
02	0602148A / AI7: Alternative Concept Engine Technology	0602148A/AM4
02	0602148A / AK1: UAS Survivability Technology	0603465A/AK3
02	0602148A / AK6: Advanced Rotorcraft Armaments Protection System Te	0603465A/AK7, 0633465A/CA8
02	0602148A / AM2: Aircraft and Aircrew Protection Technology	0602148A/AJ4
02	0602150A / AD7: Missile Fire Control Sensors Technology	0602150A/AD3
02	0602787A / 874: Cbt Casualty Care Tech	0602787A/MM4
03	0603002A / MG4: Tech Base/Enabling Res in Mil Occup Med Adv Tech	0603002A/MN7, MN9, MO3, MO8, MP3
03	0603002A / MM5: Tech Base/Enabling Res Combat Cas Care Adv Tech	0603002A/MN3, MN4, MN5, MO2, MO4, MO7
03	0603002A / MM9: Tech Base/Enabling Rsrch for Infect Dis Adv Tech	0603002A/MO9, 0602787A/MM8
03	0603002A / MN8: Drugs to Prevent and Treat Malaria Advanced Tech	0602787A/MM8
03	0603002A / MO3: Military Occupational Fitness Standards Adv Tech	0603002A/MN7
03	0603118A / AZ8: Soldier Squad Small Arms Armaments Adv Tech	0602143/AY8, 0603463A/AQ1
03	0603462A / BH3: C4ISR Modular Autonomy Advanced Technology	0603462A/BZ9
03	0603462A / BI1: Protection for Autonomous Systems Adv Tech	0603462A/BG7
03	0603462A / BJ6: Hydrogen Based Combat System Advanced Technology	0603462A/BH6
03	0603462A / BJ8: Detection of Explosive Hazards Advanced Technology	0602145A/BF9
03	0603463A / AR2: Energy Informed Operations Advanced Technology	0603465A/AM5
03	0603463A / AU6: Automated Analytics for Operational Environment AT	0602146/AT7
03	0603464A / AF4: Missile Simulation Advanced Technology	0602147/AF8
03	0603464A / AH3: Single Multi-mission Attack Missile Adv Tech	0603465A/AK5
03	0603464A / BS3: Strategic Missile Advanced Technology	0603464A/BY2
03	0603465A / AI6: Next Gen Tactical UAS TD Advanced Technology	0603465A
03	0603465A / AM3: Aircraft and Aircrew Protection Advanced Tech	0603465A/AJ5
03	0603466A / AC8: Low Cost Extended Range Air Defense Adv Tech	0603466A/AD4
04	1206120A / FJ8: Assured Positioning, Navigation and Timing (PNT)	0604120A/ED5, BV4

04	1206120A / FJ9: Dismounted A-PNT	0604120A/EH8
04	1206120A / FK2: Mounted A-PNT	0604120A/EJ2
04	1206120A / FK3: Anti-Jam Antenna	0604120A/EJ2
04	1206308A / FE5: Space And Missile Defense Integration	0603308A/990
04	0603639A / EB8: OWL for Small Caliber Ammunition	0604802A/EP4
04	0603639A / EC2: Adv Armor-Piercing (ADVAP) for Small Cal Ammo	0604802A/FL4
04	0603639A / EU3: .50 Caliber All-Purpose Tactical Cartridge (APTC)	0604802A/EU5
04	0604541A / BT1: Interoperability	0604541A/BT3, BT5
04	0604541A / BT4: Network Technology Maturation Initiatives (NTMI)	0604541A/BT5
05	0604798A / DY3: NIE Test & Evaluation	0604798A/DY7
05	0604798A / DZ6: Army Integration Management & Coordination	0605054A/FL7
06	0605326A / 33B: Soldier-Centered Analyses For Future Force	0605604A/675
07	1203142A / FE1: Dscs-Dcs (Phase II)	0303142A/253
07	1203142A / FE2: MILSATCOM System Engineering	0303142A/456
07	1203142A / FI8: Protected Anti-JAM Tactical SATCOM	0303142A/456
07	1208053A / FE7: Joint Tact Grd Station-P3I(MIP)	0208053A/635
07	0303028A / FG2: Counterintelligence & Human Intel Modernization	0607150A/BS5
07	0303028A / H13: Information Dominance Center (IDC) - Tiara	0607150A/BS5
07	0305232A / RA7: RQ-11 Raven (MIP)	0604101A/BR6, 0605205A/BR7

Program Terminations (including transfers to Procurement and Sustainment):

Budget Activity	***OSDPE / Project***	***Project Title***
02	0602146A / AN5	Protected SATCOM-WB Global SATCOM Inter Canc Tech
02	0602146A / AU5	Automated Analytics for Operational Environment
02	0602146A / AW5	Modular GPS Independent Sensors Technology
02	0602147A / AH2	Single Multi-mission Attack Missile (SMAM) Technol
02	0602213A / CY9	Decoy and Deterrence Technology
02	0602787A / VB4	System Biology And Network Science Technology
03	0603457A / 7CY	Decoy and Deterrence Advanced Technology

03	0603462A / BF5	Adv Lethality & Accuracy Sys for Med Cal Adv Tech
03	0603463A / AW2	Autonomous Navigation Advanced Technology
03	0603464A / AE6	Strategic Long Range Cannon Advanced Technology
03	0603465A / AI4	Joint Multi-Role (JMR) Demonstration Advanced Tech
03	0603465A / AL6	Degraded Vis Environ Mitigation (DVE-M) Adv Tech
04	1206120A / FK1	PSEUDOLITES
04	0603804A / G11	Adv Elec Energy Con Ad
04	0604115A / AX8	Adv Leth and Accuracy Sys for Med Calber (ALAS-MC)
04	0604644A / MR1	Mobile Intermediate Range Missile
05	0604201A / EW7	Degraded Visual Environment
05	0604601A / FI2	Lightweight 30mm Cannon
05	0604710A / L76	Dismounted Fire Support Laser Targeting Systems
05	0604802A / ED7	Advanced Multipurpose (AMP) Cartridge
05	0604802A / EU7	Enhanced Lethality Cannon Munitions
05	0604804A / FG4	Ultra-Lightweight Camouflage Net System (ULCANS)
05	0604804A / L43	ENGINEER SUPPORT EQUIPMENT - ED
05	0604827A / S65	Platoon Power Generator
05	0604852A / XU9	Active Protection System
05	0604854A / 509	LIGHTWEIGHT 155M HOWITZER
05	0605013A / 193	Medical Communications For Combat Casualty
05	0605013A / XV6	Army Leader Dashboard
05	0605029A / EQ2	IntegGrdSecSurvRespC(IGSSR-C)
05	0605034A / EQ4	Tactical Security System (TSS)
05	0605036A / EQ5	Combating Weapons of Mass Destruction (CWMD)
05	0605049A / XT4	Advanced Threat Detection System (ATDS)
05	0605053A / FB2	Man Transportable Robotic System (MTRS) Inc II
05	0605053A / FB9	MTRS Standardization
06	0605805A / 857	DoD Explosives Safety Standards
06	0606001A / FD4	Military Ground-Based CREW Technology
07	0303150A / C86	Army Global C2 System

07	0305233A / RQ7	RQ-7 Shadow UAV
07	0307665A / FL5	Next Gen Biometric Collection Capability (MIP)
07	0607138A / ES5	Fixed Wing Product Improvement Program
07	0607665A / DT2	Non-MIP Biometrics

3. Classification: This document contains no classified data. Appropriately cleared individuals can obtain further information on Classified/Special Access Programs by contacting the Department of the Army.

Department of Defense
FY 2021President's Budget
Exhibit R-1 FY 2021 President's Budget
Total Obligational Authority
(Dollars in Thousands)

17 Jan 2020

Appropriation	FY 2019 (Base + OCO)	FY 2020 Base Enacted	FY 2020 Emergency	FY 2020 OCO Enacted	FY 2020 Total Enacted (Base+Emerg+ OCO)
Research, Development, Test & Eval, Army	11,371,268	12,543,435		147,304	12,690,739
Total Research, Development, Test & Evaluation	11,371,268	12,543,435		147,304	12,690,739

Department of Defense
FY 2021President's Budget
Exhibit R-1 FY 2021 President's Budget
Total Obligational Authority
(Dollars in Thousands)

17 Jan 2020

Appropriation	FY 2021 Base	FY 2021 OCO for Base Requirements	FY 2021 OCO for Direct War and Enduring Costs	FY 2021 Total OCO	FY 2021 Total (Base + OCO)
Research, Development, Test & Eval, Army	12,587,343		182,824	182,824	12,770,167
Total Research, Development, Test & Evaluation	12,587,343		182,824	182,824	12,770,167

Department of Defense
FY 2021President's Budget
Exhibit R-1 FY 2021 President's Budget
Total Obligational Authority
(Dollars in Thousands)

17 Jan 2020

Summary Recap of Budget Activities	FY 2019 (Base + OCO)	FY 2020 Base Enacted	FY 2020 Emergency	FY 2020 OCO Enacted	FY 2020 Total Enacted (Base+Emerg+ OCO)
Basic Research	491,263	574,484			574,484
Applied Research	1,553,764	1,259,374			1,259,374
Advanced Technology Development	1,561,576	1,531,516			1,531,516
Advanced Component Development & Prototypes	1,213,569	2,975,681		11,114	2,986,795
System Development & Demonstration	3,119,552	2,989,779		100,147	3,089,926
Management Support	1,710,179	1,368,475		1,875	1,370,350
Operational Systems Development	1,721,365	1,844,126		34,168	1,878,294
Software and Digital Technology Pilot Programs					
Total Research, Development, Test & Evaluation	11,371,268	12,543,435		147,304	12,690,739
Summary Recap of FYDP Programs					
General Purpose Forces	646,373	765,324			765,324
Intelligence and Communications	311,699	236,563		37,368	273,931
Research and Development	10,090,836	11,139,975		109,936	11,249,911
Central Supply and Maintenance	106,766	108,348			108,348
Administration and Associated Activities	358				
Space	209,281	285,952			285,952
Classified Programs	5,955	7,273			7,273
Total Research, Development, Test & Evaluation	11,371,268	12,543,435		147,304	12,690,739

Department of Defense
FY 2021President's Budget
Exhibit R-1 FY 2021 President's Budget
Total Obligational Authority
(Dollars in Thousands)

17 Jan 2020

Summary Recap of Budget Activities	FY 2021 Base	FY 2021 OCO for Base Requirements	FY 2021 OCO for Direct War and Enduring Costs	FY 2021 Total OCO	FY 2021 Total (Base + OCO)
Basic Research	463,359				463,359
Applied Research	920,881		2,000	2,000	922,881
Advanced Technology Development	1,203,590				1,203,590
Advanced Component Development & Prototypes	3,421,608		2,520	2,520	3,424,128
System Development & Demonstration	3,199,798		97,825	97,825	3,297,623
Management Support	1,333,123		5,137	5,137	1,338,260
Operational Systems Development	1,998,539		75,342	75,342	2,073,881
Software and Digital Technology Pilot Programs	46,445				46,445
Total Research, Development, Test & Evaluation	12,587,343		182,824	182,824	12,770,167
Summary Recap of FYDP Programs					
General Purpose Forces	923,370		2,300	2,300	925,670
Intelligence and Communications	309,698		76,942	76,942	386,640
Research and Development	11,289,280		103,582	103,582	11,392,862
Central Supply and Maintenance	61,012				61,012
Administration and Associated Activities					
Space					
Classified Programs	3,983				3,983
Total Research, Development, Test & Evaluation	12,587,343		182,824	182,824	12,770,167

Department of the Army
FY 2021President's Budget
Exhibit R-1 FY 2021 President's Budget
Total Obligational Authority
(Dollars in Thousands)

17 Jan 2020

Summary Recap of Budget Activities	FY 2019 (Base + OCO)	FY 2020 Base Enacted	FY 2020 Emergency	FY 2020 OCO Enacted	FY 2020 Total Enacted (Base+Emerg+ OCO)
Basic Research	491,263	574,484			574,484
Applied Research	1,553,764	1,259,374			1,259,374
Advanced Technology Development	1,561,576	1,531,516			1,531,516
Advanced Component Development & Prototypes	1,213,569	2,975,681		11,114	2,986,795
System Development & Demonstration	3,119,552	2,989,779		100,147	3,089,926
Management Support	1,710,179	1,368,475		1,875	1,370,350
Operational Systems Development	1,721,365	1,844,126		34,168	1,878,294
Software and Digital Technology Pilot Programs					
Total Research, Development, Test & Evaluation	11,371,268	12,543,435		147,304	12,690,739

Summary Recap of FYDP Programs					
General Purpose Forces	646,373	765,324			765,324
Intelligence and Communications	311,699	236,563		37,368	273,931
Research and Development	10,090,836	11,139,975		109,936	11,249,911
Central Supply and Maintenance	106,766	108,348			108,348
Administration and Associated Activities	358				
Space	209,281	285,952			285,952
Classified Programs	5,955	7,273			7,273
Total Research, Development, Test & Evaluation	11,371,268	12,543,435		147,304	12,690,739

Department of the Army
FY 2021President's Budget
Exhibit R-1 FY 2021 President's Budget
Total Obligational Authority
(Dollars in Thousands)

17 Jan 2020

Summary Recap of Budget Activities	FY 2021 Base	FY 2021 OCO for Base Requirements	FY 2021 OCO for Direct War and Enduring Costs	FY 2021 Total OCO	FY 2021 Total (Base + OCO)
Basic Research	463,359				463,359
Applied Research	920,881		2,000	2,000	922,881
Advanced Technology Development	1,203,590				1,203,590
Advanced Component Development & Prototypes	3,421,608		2,520	2,520	3,424,128
System Development & Demonstration	3,199,798		97,825	97,825	3,297,623
Management Support	1,333,123		5,137	5,137	1,338,260
Operational Systems Development	1,998,539		75,342	75,342	2,073,881
Software and Digital Technology Pilot Programs	46,445				46,445
Total Research, Development, Test & Evaluation	12,587,343		182,824	182,824	12,770,167
Summary Recap of FYDP Programs					
General Purpose Forces	923,370		2,300	2,300	925,670
Intelligence and Communications	309,698		76,942	76,942	386,640
Research and Development	11,289,280		103,582	103,582	11,392,862
Central Supply and Maintenance	61,012				61,012
Administration and Associated Activities					
Space					
Classified Programs	3,983				3,983
Total Research, Development, Test & Evaluation	12,587,343		182,824	182,824	12,770,167

Department of the Army
FY 2021President's Budget
Exhibit R-1 FY 2021 President's Budget
Total Obligational Authority
(Dollars in Thousands)

17 Jan 2020

Appropriation: 2040A Research, Development, Test & Eval, Army

Line No	Program Element Number	Item	Act	FY 2019 (Base + OCO)	FY 2020 Base Enacted	FY 2020 Emergency	FY 2020 OCO Enacted	FY 2020 Total Enacted (Base+Emerg+ OCO)	Sec
1	0601101A	In-House Laboratory Independent Research	01	11,391					U
2	0601102A	Defense Research Sciences	01	306,347	354,480			354,480	U
3	0601103A	University Research Initiatives	01	62,813	87,858			87,858	U
4	0601104A	University and Industry Research Centers	01	110,712	127,164			127,164	U
5	0601121A	Cyber Collaborative Research Alliance	01		4,982			4,982	U
	Basic Research			491,263	574,484			574,484	
6	0602105A	Materials Technology	02	79,432					U
7	0602115A	Biomedical Technology	02						U
8	0602120A	Sensors and Electronic Survivability	02	90,023					U
9	0602122A	TRACTOR HIP	02	8,674					U
10	0602126A	TRACTOR JACK	02	400					U
11	0602134A	Counter Improvised-Threat Advanced Studies	02						U
12	0602141A	Lethality Technology	02		69,961			69,961	U
13	0602142A	Army Applied Research	02		30,819			30,819	U
14	0602143A	Soldier Lethality Technology	02		145,900			145,900	U
15	0602144A	Ground Technology	02		143,899			143,899	U
16	0602145A	Next Generation Combat Vehicle Technology	02		263,547			263,547	U
17	0602146A	Network C3I Technology	02		138,016			138,016	U

Department of the Army
FY 2021President's Budget
Exhibit R-1 FY 2021 President's Budget
Total Obligational Authority
(Dollars in Thousands)

17 Jan 2020

Appropriation: 2040A Research, Development, Test & Eval, Army

Line No	Program Element Number	Item	Act	FY 2021 Base	FY 2021 OCO for Base Requirements	FY 2021 OCO for Direct War and Enduring Costs	FY 2021 Total OCO	FY 2021 Total (Base + OCO)	Sec
1	0601101A	In-House Laboratory Independent Research	01						U
2	0601102A	Defense Research Sciences	01	303,257				303,257	U
3	0601103A	University Research Initiatives	01	67,148				67,148	U
4	0601104A	University and Industry Research Centers	01	87,877				87,877	U
5	0601121A	Cyber Collaborative Research Alliance	01	5,077				5,077	U
	Basic	Research		463,359				463,359	
6	0602105A	Materials Technology	02						U
7	0602115A	Biomedical Technology	02	11,835				11,835	U
8	0602120A	Sensors and Electronic Survivability	02						U
9	0602122A	TRACTOR HIP	02						U
10	0602126A	TRACTOR JACK	02						U
11	0602134A	Counter Improvised-Threat Advanced Studies	02	2,000				2,000	U
12	0602141A	Lethality Technology	02	42,425				42,425	U
13	0602142A	Army Applied Research	02	30,757				30,757	U
14	0602143A	Soldier Lethality Technology	02	125,435				125,435	U
15	0602144A	Ground Technology	02	28,047				28,047	U
16	0602145A	Next Generation Combat Vehicle Technology	02	217,565		2,000	2,000	219,565	U
17	0602146A	Network C3I Technology	02	114,404				114,404	U

Department of the Army
FY 2021President's Budget
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(Dollars in Thousands)

17 Jan 2020

Appropriation: 2040A Research, Development, Test & Eval, Army

Line No	Program Element Number	Item	Act	FY 2019 (Base + OCO)	FY 2020 Base Enacted	FY 2020 Emergency	FY 2020 OCO Enacted	FY 2020 Total Enacted (Base+Emerg+ OCO)	Sec
18	0602147A	Long Range Precision Fires Technology	02		120,327			120,327	U
19	0602148A	Future Verticle Lift Technology	02		98,359			98,359	U
20	0602150A	Air and Missile Defense Technology	02		95,771			95,771	U
21	0602211A	Aviation Technology	02	80,424					U
22	0602213A	C3I Applied Cyber	02		18,947			18,947	U
23	0602270A	Electronic Warfare Technology	02	25,127					U
24	0602303A	Missile Technology	02	90,496					U
25	0602307A	Advanced Weapons Technology	02	43,454					U
26	0602308A	Advanced Concepts and Simulation	02	28,623					U
27	0602601A	Combat Vehicle and Automotive Technology	02	102,899					U
28	0602618A	Ballistics Technology	02	86,737					U
29	0602622A	Chemical, Smoke and Equipment Defeating Technology	02	4,884					U
30	0602623A	Joint Service Small Arms Program	02	11,890					U
31	0602624A	Weapons and Munitions Technology	02	379,833					U
32	0602705A	Electronics and Electronic Devices	02	98,855					U
33	0602709A	Night Vision Technology	02	33,218					U
34	0602712A	Countermine Systems	02	26,594					U
35	0602716A	Human Factors Engineering Technology	02	23,755					U
36	0602720A	Environmental Quality Technology	02	15,364					U

Department of the Army
FY 2021President's Budget
Exhibit R-1 FY 2021 President's Budget
Total Obligational Authority
(Dollars in Thousands)

17 Jan 2020

Appropriation: 2040A Research, Development, Test & Eval, Army

Line No	Program Element Number	Item	Act	FY 2021 Base	FY 2021 OCO for Base Requirements	FY 2021 OCO for Direct War and Enduring Costs	FY 2021 Total OCO	FY 2021 Total (Base + OCO)	Sec
18	0602147A	Long Range Precision Fires Technology	02	60,553				60,553	U
19	0602148A	Future Verticle Lift Technology	02	96,484				96,484	U
20	0602150A	Air and Missile Defense Technology	02	56,298				56,298	U
21	0602211A	Aviation Technology	02						U
22	0602213A	C3I Applied Cyber	02	18,816				18,816	U
23	0602270A	Electronic Warfare Technology	02						U
24	0602303A	Missile Technology	02						U
25	0602307A	Advanced Weapons Technology	02						U
26	0602308A	Advanced Concepts and Simulation	02						U
27	0602601A	Combat Vehicle and Automotive Technology	02						U
28	0602618A	Ballistics Technology	02						U
29	0602622A	Chemical, Smoke and Equipment Defeating Technology	02						U
30	0602623A	Joint Service Small Arms Program	02						U
31	0602624A	Weapons and Munitions Technology	02						U
32	0602705A	Electronics and Electronic Devices	02						U
33	0602709A	Night Vision Technology	02						U
34	0602712A	Countermine Systems	02						U
35	0602716A	Human Factors Engineering Technology	02						U
36	0602720A	Environmental Quality Technology	02						U

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37	0602782A	Command, Control, Communications Technology	02	51,685					U
38	0602783A	Computer and Software Technology	02	14,622					U
39	0602784A	Military Engineering Technology	02	96,922					U
40	0602785A	Manpower/Personnel/Training Technology	02	17,157	20,873			20,873	U
41	0602786A	Warfighter Technology	02	55,467					U
42	0602787A	Medical Technology	02	87,229	112,955			112,955	U
	Applied Research			1,553,764	1,259,374			1,259,374	
43	0603001A	Warfighter Advanced Technology	03	40,501					U
44	0603002A	Medical Advanced Technology	03	94,575	83,030			83,030	U
45	0603003A	Aviation Advanced Technology	03	165,035					U
46	0603004A	Weapons and Munitions Advanced Technology	03	240,862					U
47	0603005A	Combat Vehicle and Automotive Advanced Technology	03	171,448					U
48	0603006A	Space Application Advanced Technology	03	48,542					U
49	0603007A	Manpower, Personnel and Training Advanced Technology	03	6,270	11,038			11,038	U
50	0603009A	TRACTOR HIKE	03	22,631					U
51	0603015A	Next Generation Training & Simulation Systems	03	27,711					U
52	0603115A	Medical Development	03						U

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37	0602782A	Command, Control, Communications Technology	02						U
38	0602783A	Computer and Software Technology	02						U
39	0602784A	Military Engineering Technology	02						U
40	0602785A	Manpower/Personnel/Training Technology	02	20,766				20,766	U
41	0602786A	Warfighter Technology	02						U
42	0602787A	Medical Technology	02	95,496				95,496	U
		Applied Research		920,881		2,000	2,000	922,881	
43	0603001A	Warfighter Advanced Technology	03						U
44	0603002A	Medical Advanced Technology	03	38,896				38,896	U
45	0603003A	Aviation Advanced Technology	03						U
46	0603004A	Weapons and Munitions Advanced Technology	03						U
47	0603005A	Combat Vehicle and Automotive Advanced Technology	03						U
48	0603006A	Space Application Advanced Technology	03						U
49	0603007A	Manpower, Personnel and Training Advanced Technology	03	11,659				11,659	U
50	0603009A	TRACTOR HIKE	03						U
51	0603015A	Next Generation Training & Simulation Systems	03						U
52	0603115A	Medical Development	03	27,723				27,723	U

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53	0603117A	Army Advanced Technology Development	03		66,338			66,338	U
54	0603118A	Soldier Lethality Advanced Technology	03		135,968			135,968	U
55	0603119A	Ground Advanced Technology	03		136,793			136,793	U
56	0603125A	Combating Terrorism - Technology Development	03	43,910					U
57	0603130A	TRACTOR NAIL	03	4,896					U
58	0603131A	TRACTOR EGGS	03	6,041					U
59	0603134A	Counter Improvised-Threat Simulation	03						U
60	0603270A	Electronic Warfare Technology	03	40,461					U
61	0603313A	Missile and Rocket Advanced Technology	03	92,404					U
62	0603322A	TRACTOR CAGE	03	16,845					U
63	0603457A	C3I Cyber Advanced Development	03		23,769			23,769	U
64	0603461A	High Performance Computing Modernization Program	03	211,457	224,755			224,755	U
65	0603462A	Next Generation Combat Vehicle Advanced Technology	03		260,535			260,535	U
66	0603463A	Network C3I Advanced Technology	03		142,899			142,899	U
67	0603464A	Long Range Precision Fires Advanced Technology	03		189,386			189,386	U
68	0603465A	Future Vertical Lift Advanced Technology	03		174,892			174,892	U

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53	0603117A	Army Advanced Technology Development	03	62,663				62,663	U
54	0603118A	Soldier Lethality Advanced Technology	03	109,608				109,608	U
55	0603119A	Ground Advanced Technology	03	14,795				14,795	U
56	0603125A	Combating Terrorism - Technology Development	03						U
57	0603130A	TRACTOR NAIL	03						U
58	0603131A	TRACTOR EGGS	03						U
59	0603134A	Counter Improvised-Threat Simulation	03	25,000				25,000	U
60	0603270A	Electronic Warfare Technology	03						U
61	0603313A	Missile and Rocket Advanced Technology	03						U
62	0603322A	TRACTOR CAGE	03						U
63	0603457A	C3I Cyber Advanced Development	03	23,357				23,357	U
64	0603461A	High Performance Computing Modernization Program	03	188,024				188,024	U
65	0603462A	Next Generation Combat Vehicle Advanced Technology	03	199,358				199,358	U
66	0603463A	Network C3I Advanced Technology	03	158,608				158,608	U
67	0603464A	Long Range Precision Fires Advanced Technology	03	121,060				121,060	U
68	0603465A	Future Vertical Lift Advanced Technology	03	156,194				156,194	U

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69	0603466A	Air and Missile Defense Advanced Technology	03		82,113			82,113	U
70	0603606A	Landmine Warfare and Barrier Advanced Technology	03	16,860					U
71	0603607A	Joint Service Small Arms Program	03	22,628					U
72	0603710A	Night Vision Advanced Technology	03	69,094					U
73	0603728A	Environmental Quality Technology Demonstrations	03	28,079					U
74	0603734A	Military Engineering Advanced Technology	03	100,359					U
75	0603772A	Advanced Tactical Computer Science and Sensor Technology	03	45,799					U
76	0603794A	C3 Advanced Technology	03	45,168					U
77	0603920A	Humanitarian Demining	03						U
		Advanced Technology Development		1,561,576	1,531,516			1,531,516	
78	0603305A	Army Missle Defense Systems Integration	04	60,301	59,487			59,487	U
79	0603308A	Army Space Systems Integration	04						U
80	0603327A	Air and Missile Defense Systems Engineering	04	44,743	52,480		500	52,980	U
81	0603619A	Landmine Warfare and Barrier - Adv Dev	04	40,255	82,915			82,915	U
82	0603627A	Smoke, Obscurant and Target Defeating Sys-Adv Dev	04	19,852					U
83	0603639A	Tank and Medium Caliber Ammunition	04	40,358	77,696			77,696	U

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69	0603466A	Air and Missile Defense Advanced Technology	03	58,130				58,130	U
70	0603606A	Landmine Warfare and Barrier Advanced Technology	03						U
71	0603607A	Joint Service Small Arms Program	03						U
72	0603710A	Night Vision Advanced Technology	03						U
73	0603728A	Environmental Quality Technology Demonstrations	03						U
74	0603734A	Military Engineering Advanced Technology	03						U
75	0603772A	Advanced Tactical Computer Science and Sensor Technology	03						U
76	0603794A	C3 Advanced Technology	03						U
77	0603920A	Humanitarian Demining	03	8,515				8,515	U
		Advanced Technology Development		1,203,590				1,203,590	
78	0603305A	Army Missle Defense Systems Integration	04	11,062				11,062	U
79	0603308A	Army Space Systems Integration	04	26,230				26,230	U
80	0603327A	Air and Missile Defense Systems Engineering	04	26,482		500	500	26,982	U
81	0603619A	Landmine Warfare and Barrier - Adv Dev	04	64,092				64,092	U
82	0603627A	Smoke, Obscurant and Target Defeating Sys-Adv Dev	04						U
83	0603639A	Tank and Medium Caliber Ammunition	04	92,753				92,753	U

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84	0603645A	Armored System Modernization - Adv Dev	04	80,106	144,234			144,234	U
85	0603747A	Soldier Support and Survivability	04	8,067	6,514		3,000	9,514	U
86	0603766A	Tactical Electronic Surveillance System - Adv Dev	04	35,667	37,490			37,490	U
87	0603774A	Night Vision Systems Advanced Development	04	7,072	200,791			200,791	U
88	0603779A	Environmental Quality Technology - Dem/Val	04	14,190	19,561			19,561	U
89	0603790A	NATO Research and Development	04	3,564	5,406			5,406	U
90	0603801A	Aviation - Adv Dev	04	93,885	505,890			505,890	U
91	0603804A	Logistics and Engineer Equipment - Adv Dev	04	18,845	6,254		1,085	7,339	U
92	0603807A	Medical Systems - Adv Dev	04	38,371	36,975			36,975	U
93	0603827A	Soldier Systems - Advanced Development	04	30,384	26,113			26,113	U
94	0604017A	Robotics Development	04	70,745	84,381			84,381	U
95	0604020A	Cross Functional Team (CFT) Advanced Development & Prototyping	04	8,225					U
96	0604021A	Electronic Warfare Technology Maturation (MIP)	04		23,043			23,043	U
97	0604035A	Low Earth Orbit (LEO) Satellite Capability	04						U
98	0604100A	Analysis Of Alternatives	04	9,396	10,023			10,023	U

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84	0603645A	Armored System Modernization - Adv Dev	04	151,478				151,478	U
85	0603747A	Soldier Support and Survivability	04	5,841				5,841	U
86	0603766A	Tactical Electronic Surveillance System - Adv Dev	04	194,775				194,775	U
87	0603774A	Night Vision Systems Advanced Development	04	24,316				24,316	U
88	0603779A	Environmental Quality Technology - Dem/Val	04	13,387				13,387	U
89	0603790A	NATO Research and Development	04	4,762				4,762	U
90	0603801A	Aviation - Adv Dev	04	647,937				647,937	U
91	0603804A	Logistics and Engineer Equipment - Adv Dev	04	4,761				4,761	U
92	0603807A	Medical Systems - Adv Dev	04	28,520				28,520	U
93	0603827A	Soldier Systems - Advanced Development	04	26,138				26,138	U
94	0604017A	Robotics Development	04	121,207				121,207	U
95	0604020A	Cross Functional Team (CFT) Advanced Development & Prototyping	04						U
96	0604021A	Electronic Warfare Technology Maturation (MIP)	04	22,840				22,840	U
97	0604035A	Low Earth Orbit (LEO) Satellite Capability	04	22,678				22,678	U
98	0604100A	Analysis Of Alternatives	04	10,082				10,082	U

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99	0604101A	Small Unmanned Aerial Vehicle (SUAV) (6.4)	04						U
100	0604113A	Future Tactical Unmanned Aircraft System (FTUAS)	04	12,393	40,745			40,745	U
101	0604114A	Lower Tier Air Missile Defense (LTAMD) Sensor	04	84,981	379,772			379,772	U
102	0604115A	Technology Maturation Initiatives	04	91,749	179,676			179,676	U
103	0604117A	Maneuver - Short Range Air Defense (M-SHORAD)	04	75,711	42,900			42,900	U
104	0604118A	TRACTOR BEAM	04	52,894					U
105	0604119A	Army Advanced Component Development & Prototyping	04		112,806		4,529	117,335	U
106	0604120A	Assured Positioning, Navigation and Timing (PNT)	04						U
107	0604121A	Synthetic Training Environment Refinement & Prototyping	04	39,890	103,621			103,621	U
108	0604134A	Counter Improvised-Threat Demonstration, Prototype Development, and Testing	04						U
109	0604182A	Hypersonics	04		404,000			404,000	U
110	0604319A	Indirect Fire Protection Capability Increment 2-Intercept (IFPC2)	04	10,324					U
111	0604403A	Future Interceptor	04		2,000			2,000	U
112	0604541A	Unified Network Transport	04		29,700			29,700	U
113	0604644A	Mobile Medium Range Missile	04		5,000			5,000	U

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99	0604101A	Small Unmanned Aerial Vehicle (SUAV) (6.4)	04	1,378				1,378	U
100	0604113A	Future Tactical Unmanned Aircraft System (FTUAS)	04	40,083				40,083	U
101	0604114A	Lower Tier Air Missile Defense (LTAMD) Sensor	04	376,373				376,373	U
102	0604115A	Technology Maturation Initiatives	04	156,834				156,834	U
103	0604117A	Maneuver - Short Range Air Defense (M-SHORAD)	04	4,995				4,995	U
104	0604118A	TRACTOR BEAM	04						U
105	0604119A	Army Advanced Component Development & Prototyping	04	170,490				170,490	U
106	0604120A	Assured Positioning, Navigation and Timing (PNT)	04	128,125				128,125	U
107	0604121A	Synthetic Training Environment Refinement & Prototyping	04	129,547				129,547	U
108	0604134A	Counter Improvised-Threat Demonstration, Prototype Development, and Testing	04	13,831				13,831	U
109	0604182A	Hypersonics	04	801,417				801,417	U
110	0604319A	Indirect Fire Protection Capability Increment 2-Intercept (IFPC2)	04						U
111	0604403A	Future Interceptor	04	7,992				7,992	U
112	0604541A	Unified Network Transport	04	40,677				40,677	U
113	0604644A	Mobile Medium Range Missile	04						U

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114	0604785A	Integrated Base Defense (Budget Activity 4)	04				2,000	2,000	U
115	0305251A	Cyberspace Operations Forces and Force Support	04	52,817	52,102			52,102	U
116	1206120A	Assured Positioning, Navigation and Timing (PNT)	04	123,364	139,110			139,110	U
117	1206308A	Army Space Systems Integration	04	45,420	104,996			104,996	U
		Advanced Component Development & Prototypes		1,213,569	2,975,681		11,114	2,986,795	
118	0604201A	Aircraft Avionics	05	31,401	8,414			8,414	U
119	0604270A	Electronic Warfare Development	05	56,310	59,539			59,539	U
120	0604328A	TRACTOR CAGE	05	27,050					U
121	0604601A	Infantry Support Weapons	05	74,629	87,179			87,179	U
122	0604604A	Medium Tactical Vehicles	05	3,905					U
123	0604611A	JAVELIN	05	5,250	14,997			14,997	U
124	0604622A	Family of Heavy Tactical Vehicles	05	11,182	13,125			13,125	U
125	0604633A	Air Traffic Control	05	11,580	5,781			5,781	U
126	0604642A	Light Tactical Wheeled Vehicles	05	1,013	2,965			2,965	U
127	0604645A	Armored Systems Modernization (ASM) - Eng Dev	05	359,017	285,136			285,136	U
128	0604710A	Night Vision Systems - Eng Dev	05	139,337	143,696			143,696	U
129	0604713A	Combat Feeding, Clothing, and Equipment	05	4,393	7,393			7,393	U

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114	0604785A	Integrated Base Defense (Budget Activity 4)	04			2,020	2,020	2,020	U
115	0305251A	Cyberspace Operations Forces and Force Support	04	50,525				50,525	U
116	1206120A	Assured Positioning, Navigation and Timing (PNT)	04						U
117	1206308A	Army Space Systems Integration	04						U
		Advanced Component Development & Prototypes		3,421,608		2,520	2,520	3,424,128	
118	0604201A	Aircraft Avionics	05	2,764				2,764	U
119	0604270A	Electronic Warfare Development	05	62,426				62,426	U
120	0604328A	TRACTOR CAGE	05						U
121	0604601A	Infantry Support Weapons	05	91,574				91,574	U
122	0604604A	Medium Tactical Vehicles	05	8,523				8,523	U
123	0604611A	JAVELIN	05	7,493				7,493	U
124	0604622A	Family of Heavy Tactical Vehicles	05	24,792				24,792	U
125	0604633A	Air Traffic Control	05	3,511				3,511	U
126	0604642A	Light Tactical Wheeled Vehicles	05	1,976				1,976	U
127	0604645A	Armored Systems Modernization (ASM) - Eng Dev	05	135,488				135,488	U
128	0604710A	Night Vision Systems - Eng Dev	05	61,445				61,445	U
129	0604713A	Combat Feeding, Clothing, and Equipment	05	2,814				2,814	U

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130	0604715A	Non-System Training Devices - Eng Dev	05	42,604	30,912			30,912	U
131	0604741A	Air Defense Command, Control and Intelligence - Eng Dev	05	208,965	33,502			33,502	U
132	0604742A	Constructive Simulation Systems Development	05	21,354	11,636			11,636	U
133	0604746A	Automatic Test Equipment Development	05	10,104	10,915			10,915	U
134	0604760A	Distributive Interactive Simulations (DIS) - Eng Dev	05	8,423	7,801			7,801	U
135	0604768A	Brilliant Anti-Armor Submunition (BAT)	05	6,568	20,000			20,000	U
136	0604780A	Combined Arms Tactical Trainer (CATT) Core	05	20,514	9,241			9,241	U
137	0604798A	Brigade Analysis, Integration and Evaluation	05	48,030	38,303			38,303	U
138	0604802A	Weapons and Munitions - Eng Dev	05	173,713	186,323			186,323	U
139	0604804A	Logistics and Engineer Equipment - Eng Dev	05	70,096	107,826			107,826	U
140	0604805A	Command, Control, Communications Systems - Eng Dev	05	15,366	12,595			12,595	U
141	0604807A	Medical Materiel/Medical Biological Defense Equipment - Eng Dev	05	45,054	48,264			48,264	U
142	0604808A	Landmine Warfare/Barrier - Eng Dev	05	39,261	37,108			37,108	U
143	0604818A	Army Tactical Command & Control Hardware & Software	05	163,229	129,974			129,974	U
144	0604820A	Radar Development	05	37,847	95,720			95,720	U

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130	0604715A	Non-System Training Devices - Eng Dev	05	28,036				28,036	U
131	0604741A	Air Defense Command, Control and Intelligence - Eng Dev	05	43,651		27,000	27,000	70,651	U
132	0604742A	Constructive Simulation Systems Development	05	10,150				10,150	U
133	0604746A	Automatic Test Equipment Development	05	5,578				5,578	U
134	0604760A	Distributive Interactive Simulations (DIS) - Eng Dev	05	7,892				7,892	U
135	0604768A	Brilliant Anti-Armor Submunition (BAT)	05	24,975				24,975	U
136	0604780A	Combined Arms Tactical Trainer (CATT) Core	05	3,568				3,568	U
137	0604798A	Brigade Analysis, Integration and Evaluation	05	19,268				19,268	U
138	0604802A	Weapons and Munitions - Eng Dev	05	265,811				265,811	U
139	0604804A	Logistics and Engineer Equipment - Eng Dev	05	49,694				49,694	U
140	0604805A	Command, Control, Communications Systems - Eng Dev	05	11,079				11,079	U
141	0604807A	Medical Materiel/Medical Biological Defense Equipment - Eng Dev	05	49,870				49,870	U
142	0604808A	Landmine Warfare/Barrier - Eng Dev	05	9,589				9,589	U
143	0604818A	Army Tactical Command & Control Hardware & Software	05	162,513				162,513	U
144	0604820A	Radar Development	05	109,259				109,259	U

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145	0604822A	General Fund Enterprise Business System (GFEBS)	05	35,468	42,883			42,883	U
146	0604823A	Firefinder	05	25,856	17,294			17,294	U
147	0604827A	Soldier Systems - Warrior Dem/Val	05	10,044	4,803			4,803	U
148	0604852A	Suite of Survivability Enhancement Systems - EMD	05	50,380	85,198			85,198	U
149	0604854A	Artillery Systems - EMD	05	1,722	10,732			10,732	U
150	0605013A	Information Technology Development	05	74,551	88,689			88,689	U
151	0605018A	Integrated Personnel and Pay System-Army (IPPS-A)	05	158,807	102,073			102,073	U
152	0605028A	Armored Multi-Purpose Vehicle (AMPV)	05	107,521	83,830			83,830	U
153	0605029A	Integrated Ground Security Surveillance Response Capability (IGSSR-C)	05	3,104	6,699			6,699	U
154	0605030A	Joint Tactical Network Center (JTNC)	05	15,287	15,882			15,882	U
155	0605031A	Joint Tactical Network (JTN)	05	42,134	40,808			40,808	U
156	0605032A	TRACTOR TIRE	05	107,926					U
157	0605033A	Ground-Based Operational Surveillance System - Expeditionary (GBOSS-E)	05	4,980	3,847			3,847	U
158	0605034A	Tactical Security System (TSS)	05	4,326	6,928			6,928	U
159	0605035A	Common Infrared Countermeasures (CIRCM)	05	32,025	23,179			23,179	U
160	0605036A	Combating Weapons of Mass Destruction (CWMD)	05	10,883	10,000			10,000	U

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145	0604822A	General Fund Enterprise Business System (GFEBS)	05	21,201				21,201	U
146	0604823A	Firefinder	05	20,008				20,008	U
147	0604827A	Soldier Systems - Warrior Dem/Val	05	6,534				6,534	U
148	0604852A	Suite of Survivability Enhancement Systems - EMD	05	82,459				82,459	U
149	0604854A	Artillery Systems - EMD	05	11,611				11,611	U
150	0605013A	Information Technology Development	05	142,678				142,678	U
151	0605018A	Integrated Personnel and Pay System-Army (IPPS-A)	05	115,286				115,286	U
152	0605028A	Armored Multi-Purpose Vehicle (AMPV)	05	96,594				96,594	U
153	0605029A	Integrated Ground Security Surveillance Response Capability (IGSSR-C)	05						U
154	0605030A	Joint Tactical Network Center (JTNC)	05	16,264				16,264	U
155	0605031A	Joint Tactical Network (JTN)	05	31,696				31,696	U
156	0605032A	TRACTOR TIRE	05						U
157	0605033A	Ground-Based Operational Surveillance System - Expeditionary (GBOSS-E)	05	5,976				5,976	U
158	0605034A	Tactical Security System (TSS)	05						U
159	0605035A	Common Infrared Countermeasures (CIRCM)	05	23,321		2,300	2,300	25,621	U
160	0605036A	Combating Weapons of Mass Destruction (CWMD)	05						U

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161	0605038A	Nuclear Biological Chemical Reconnaissance Vehicle (NBCRV) Sensor Suite	05	14,517	6,054			6,054	U
162	0605041A	Defensive CYBER Tool Development	05	33,796	50,662			50,662	U
163	0605042A	Tactical Network Radio Systems (Low-Tier)	05	18,761	28,404			28,404	U
164	0605047A	Contract Writing System	05	40,341	17,082			17,082	U
165	0605049A	Missile Warning System Modernization (MWSM)	05	7,321	1,539			1,539	U
166	0605051A	Aircraft Survivability Development	05	56,067	55,057		77,420	132,477	U
167	0605052A	Indirect Fire Protection Capability Inc 2 - Block 1	05	92,674	194,366			194,366	U
168	0605053A	Ground Robotics	05	65,311	26,104			26,104	U
169	0605054A	Emerging Technology Initiatives	05	46,451	37,696			37,696	U
170	0605145A	Medical Products and Support Systems Development	05						U
171	0605203A	Army System Development & Demonstration	05		164,883		19,527	184,410	U
172	0605205A	Small Unmanned Aerial Vehicle (SUAV) (6.5)	05						U
173	0605380A	AMF Joint Tactical Radio System (JTRS)	05	15,379					U
174	0605450A	Joint Air-to-Ground Missile (JAGM)	05	12,440	6,585			6,585	U
175	0605457A	Army Integrated Air and Missile Defense (AIAMD)	05	318,850	208,638			208,638	U

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161	0605038A	Nuclear Biological Chemical Reconnaissance Vehicle (NBCRV) Sensor Suite	05	4,846				4,846	U
162	0605041A	Defensive CYBER Tool Development	05	28,544				28,544	U
163	0605042A	Tactical Network Radio Systems (Low-Tier)	05	28,178				28,178	U
164	0605047A	Contract Writing System	05	22,860				22,860	U
165	0605049A	Missile Warning System Modernization (MWSM)	05						U
166	0605051A	Aircraft Survivability Development	05	35,893		64,625	64,625	100,518	U
167	0605052A	Indirect Fire Protection Capability Inc 2 - Block 1	05	235,770				235,770	U
168	0605053A	Ground Robotics	05	13,710				13,710	U
169	0605054A	Emerging Technology Initiatives	05	294,739				294,739	U
170	0605145A	Medical Products and Support Systems Development	05	954				954	U
171	0605203A	Army System Development & Demonstration	05	150,201				150,201	U
172	0605205A	Small Unmanned Aerial Vehicle (SUAV) (6.5)	05	5,999				5,999	U
173	0605380A	AMF Joint Tactical Radio System (JTRS)	05						U
174	0605450A	Joint Air-to-Ground Missile (JAGM)	05	8,891				8,891	U
175	0605457A	Army Integrated Air and Missile Defense (AIAMD)	05	193,929				193,929	U

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176	0605625A	Manned Ground Vehicle	05		205,620			205,620	U
177	0605766A	National Capabilities Integration (MIP)	05	12,340	7,835			7,835	U
178	0605812A	Joint Light Tactical Vehicle (JLTV) Engineering and Manufacturing Development Ph	05		7,232			7,232	U
179	0605830A	Aviation Ground Support Equipment	05	7,616	1,664			1,664	U
180	0303032A	TROJAN - RH12	05	5,721	3,936			3,936	U
181	0303267A	Auctioned Spectrum Relocation Fund	05	18,381					U
182	0303367A	Spectrum Access Research and Development	05	285					U
183	0304270A	Electronic Warfare Development	05	8,922	15,232		3,200	18,432	U
184	1205117A	Tractor Bears	05	23,170					U
		System Development & Demonstration		3,119,552	2,989,779		100,147	3,089,926	
185	0604256A	Threat Simulator Development	06	46,732	42,117			42,117	U
186	0604258A	Target Systems Development	06	31,286	28,327			28,327	U
187	0604759A	Major T&E Investment	06	79,214	146,565			146,565	U
188	0605103A	Rand Arroyo Center	06	19,071	13,113			13,113	U
189	0605301A	Army Kwajalein Atoll	06	237,414	238,691			238,691	U
190	0605326A	Concepts Experimentation Program	06	30,667	36,922			36,922	U
191	0605502A	Small Business Innovative Research	06	303,386					U
192	0605601A	Army Test Ranges and Facilities	06	311,027	336,468			336,468	U

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176	0605625A	Manned Ground Vehicle	05	327,732				327,732	U
177	0605766A	National Capabilities Integration (MIP)	05	7,670				7,670	U
178	0605812A	Joint Light Tactical Vehicle (JLTV) Engineering and Manufacturing Development Ph	05	1,742				1,742	U
179	0605830A	Aviation Ground Support Equipment	05	1,467				1,467	U
180	0303032A	TROJAN - RH12	05	3,451				3,451	U
181	0303267A	Auctioned Spectrum Relocation Fund	05						U
182	0303367A	Spectrum Access Research and Development	05						U
183	0304270A	Electronic Warfare Development	05	55,855		3,900	3,900	59,755	U
184	1205117A	Tractor Bears	05						U
		System Development & Demonstration		3,199,798		97,825	97,825	3,297,623	
185	0604256A	Threat Simulator Development	06	14,515				14,515	U
186	0604258A	Target Systems Development	06	10,668				10,668	U
187	0604759A	Major T&E Investment	06	106,270				106,270	U
188	0605103A	Rand Arroyo Center	06	13,481				13,481	U
189	0605301A	Army Kwajalein Atoll	06	231,824				231,824	U
190	0605326A	Concepts Experimentation Program	06	54,898				54,898	U
191	0605502A	Small Business Innovative Research	06						U
192	0605601A	Army Test Ranges and Facilities	06	350,359				350,359	U

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193	0605602A	Army Technical Test Instrumentation and Targets	06	82,617	61,974			61,974	U
194	0605604A	Survivability/Lethality Analysis	06	39,886	35,075			35,075	U
195	0605606A	Aircraft Certification	06	3,796	3,461			3,461	U
196	0605702A	Meteorological Support to RDT&E Activities	06	9,495	6,233			6,233	U
197	0605706A	Materiel Systems Analysis	06	21,043	21,342			21,342	U
198	0605709A	Exploitation of Foreign Items	06	15,026	11,168			11,168	U
199	0605712A	Support of Operational Testing	06	52,139	52,723			52,723	U
200	0605716A	Army Evaluation Center	06	56,532	60,815			60,815	U
201	0605718A	Army Modeling & Sim X-Cmd Collaboration & Integ	06	2,708	2,527			2,527	U
202	0605801A	Programwide Activities	06	60,218	58,175			58,175	U
203	0605803A	Technical Information Activities	06	28,237	30,060			30,060	U
204	0605805A	Munitions Standardization, Effectiveness and Safety	06	66,678	54,458			54,458	U
205	0605857A	Environmental Quality Technology Mgmt Support	06	3,138	4,681			4,681	U
206	0605898A	Army Direct Report Headquarters - R&D - MHA	06	53,526	53,820			53,820	U
207	0606001A	Military Ground-Based CREW Technology	06	4,241	2,141			2,141	U
208	0606002A	Ronald Reagan Ballistic Missile Defense Test Site	06	60,808	62,069			62,069	U

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193	0605602A	Army Technical Test Instrumentation and Targets	06	48,475				48,475	U
194	0605604A	Survivability/Lethality Analysis	06	36,001				36,001	U
195	0605606A	Aircraft Certification	06	2,736				2,736	U
196	0605702A	Meteorological Support to RDT&E Activities	06	6,488				6,488	U
197	0605706A	Materiel Systems Analysis	06	21,859				21,859	U
198	0605709A	Exploitation of Foreign Items	06	7,936		1,000	1,000	8,936	U
199	0605712A	Support of Operational Testing	06	54,470				54,470	U
200	0605716A	Army Evaluation Center	06	63,141				63,141	U
201	0605718A	Army Modeling & Sim X-Cmd Collaboration & Integ	06	2,572				2,572	U
202	0605801A	Programwide Activities	06	87,472				87,472	U
203	0605803A	Technical Information Activities	06	26,244				26,244	U
204	0605805A	Munitions Standardization, Effectiveness and Safety	06	40,133				40,133	U
205	0605857A	Environmental Quality Technology Mgmt Support	06	1,780				1,780	U
206	0605898A	Army Direct Report Headquarters - R&D - MHA	06	55,045				55,045	U
207	0606001A	Military Ground-Based CREW Technology	06						U
208	0606002A	Ronald Reagan Ballistic Missile Defense Test Site	06	71,306				71,306	U

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209	0606003A	CounterIntel and Human Intel Modernization	06	2,636	1,050		1,875	2,925	U
210	0606105A	Medical Program-Wide Activities	06						U
211	0606942A	Assessments and Evaluations Cyber Vulnerabilities	06	88,300	4,500			4,500	U
212	0909980A	Judgment Fund Reimbursement	06	122					U
213	0909999A	Financing for Cancelled Account Adjustments	06	236					U
		Management Support		1,710,179	1,368,475		1,875	1,370,350	
214	0603778A	MLRS Product Improvement Program	07	6,574	14,615			14,615	U
215	0603813A	TRACTOR PULL	07	4,067					U
216	0605024A	Anti-Tamper Technology Support	07	7,159	8,491			8,491	U
217	0607131A	Weapons and Munitions Product Improvement Programs	07	17,992	15,645			15,645	U
218	0607133A	TRACTOR SMOKE	07	12,357					U
219	0607134A	Long Range Precision Fires (LRPF)	07	152,573	156,682			156,682	U
220	0607135A	Apache Product Improvement Program	07	22,914					U
221	0607136A	Blackhawk Product Improvement Program	07	33,906	23,039			23,039	U
222	0607137A	Chinook Product Improvement Program	07	139,003	171,471			171,471	U
223	0607138A	Fixed Wing Product Improvement Program	07	2,146					U
224	0607139A	Improved Turbine Engine Program	07	173,766	206,434			206,434	U

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209	0606003A	CounterIntel and Human Intel Modernization	06	1,063		4,137	4,137	5,200	U
210	0606105A	Medical Program-Wide Activities	06	19,891				19,891	U
211	0606942A	Assessments and Evaluations Cyber Vulnerabilities	06	4,496				4,496	U
212	0909980A	Judgment Fund Reimbursement	06						U
213	0909999A	Financing for Cancelled Account Adjustments	06						U
		Management Support		1,333,123		5,137	5,137	1,338,260	
214	0603778A	MLRS Product Improvement Program	07	10,157				10,157	U
215	0603813A	TRACTOR PULL	07						U
216	0605024A	Anti-Tamper Technology Support	07	8,682				8,682	U
217	0607131A	Weapons and Munitions Product Improvement Programs	07	20,409				20,409	U
218	0607133A	TRACTOR SMOKE	07						U
219	0607134A	Long Range Precision Fires (LRPF)	07	122,733				122,733	U
220	0607135A	Apache Product Improvement Program	07						U
221	0607136A	Blackhawk Product Improvement Program	07	11,236				11,236	U
222	0607137A	Chinook Product Improvement Program	07	46,091				46,091	U
223	0607138A	Fixed Wing Product Improvement Program	07						U
224	0607139A	Improved Turbine Engine Program	07	249,257				249,257	U

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225	0607142A	Aviation Rocket System Product Improvement and Development	07	35,211	1,927			1,927	U
226	0607143A	Unmanned Aircraft System Universal Products	07	36,488	18,132			18,132	U
227	0607145A	Apache Future Development	07		5,448			5,448	U
228	0607150A	Intel Cyber Development	07						U
229	0607312A	Army Operational Systems Development	07		45,026			45,026	U
230	0607665A	Family of Biometrics	07	2,320	1,702			1,702	U
231	0607865A	Patriot Product Improvement	07	72,895	87,430			87,430	U
232	0203728A	Joint Automated Deep Operation Coordination System (JADOCS)	07	29,782	47,398			47,398	U
233	0203735A	Combat Vehicle Improvement Programs	07	321,513	277,633			277,633	U
234	0203743A	155mm Self-Propelled Howitzer Improvements	07	35,681	199,274			199,274	U
235	0203744A	Aircraft Modifications/Product Improvement Programs	07	13,629	9,278			9,278	U
236	0203752A	Aircraft Engine Component Improvement Program	07	146	144			144	U
237	0203758A	Digitization	07	6,077	5,270			5,270	U
238	0203801A	Missile/Air Defense Product Improvement Program	07	3,588	1,287			1,287	U
239	0203802A	Other Missile Product Improvement Programs	07	4,760					U
240	0203808A	TRACTOR CARD	07	34,050					U

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225	0607142A	Aviation Rocket System Product Improvement and Development	07	17,155				17,155	U
226	0607143A	Unmanned Aircraft System Universal Products	07	7,743				7,743	U
227	0607145A	Apache Future Development	07	77,177				77,177	U
228	0607150A	Intel Cyber Development	07	14,652				14,652	U
229	0607312A	Army Operational Systems Development	07	35,851				35,851	U
230	0607665A	Family of Biometrics	07	1,324				1,324	U
231	0607865A	Patriot Product Improvement	07	187,840				187,840	U
232	0203728A	Joint Automated Deep Operation Coordination System (JADOCS)	07	44,691				44,691	U
233	0203735A	Combat Vehicle Improvement Programs	07	268,919				268,919	U
234	0203743A	155mm Self-Propelled Howitzer Improvements	07	427,254				427,254	U
235	0203744A	Aircraft Modifications/Product Improvement Programs	07	11,688				11,688	U
236	0203752A	Aircraft Engine Component Improvement Program	07	80				80	U
237	0203758A	Digitization	07	4,516				4,516	U
238	0203801A	Missile/Air Defense Product Improvement Program	07	1,288				1,288	U
239	0203802A	Other Missile Product Improvement Programs	07	79,424		2,300	2,300	81,724	U
240	0203808A	TRACTOR CARD	07						U

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241	0205402A	Integrated Base Defense - Operational System Dev	07	8,000					U
242	0205410A	Materials Handling Equipment	07	1,132					U
243	0205412A	Environmental Quality Technology - Operational System Dev	07	249	10,000			10,000	U
244	0205456A	Lower Tier Air and Missile Defense (AMD) System	07	74,295	97,746			97,746	U
245	0205778A	Guided Multiple-Launch Rocket System (GMLRS)	07	113,471	117,294			117,294	U
246	0208053A	Joint Tactical Ground System	07						U
248	0303028A	Security and Intelligence Activities	07	40,002	13,845		12,904	26,749	U
249	0303140A	Information Systems Security Program	07	40,148	25,710			25,710	U
250	0303141A	Global Combat Support System	07	51,415	60,076			60,076	U
251	0303142A	SATCOM Ground Environment (SPACE)	07						U
252	0303150A	WWMCCS/Global Command and Control System	07	1,966	2,073			2,073	U
255	0305172A	Combined Advanced Applications	07	1,500					U
256	0305179A	Integrated Broadcast Service (IBS)	07	450	459			459	U
257	0305204A	Tactical Unmanned Aerial Vehicles	07	6,000	5,097		17,050	22,147	U
258	0305206A	Airborne Reconnaissance Systems	07	26,416	11,177		2,000	13,177	U
259	0305208A	Distributed Common Ground/Surface Systems	07	27,109	28,821			28,821	U
260	0305219A	MQ-1C Gray Eagle UAS	07		5,000			5,000	U

Department of the Army
FY 2021President's Budget
Exhibit R-1 FY 2021 President's Budget
Total Obligational Authority
(Dollars in Thousands)

17 Jan 2020

Appropriation: 2040A Research, Development, Test & Eval, Army

Line No	Program Element Number	Item	Act	FY 2021 Base	FY 2021 OCO for Base Requirements	FY 2021 OCO for Direct War and Enduring Costs	FY 2021 Total OCO	FY 2021 Total (Base + OCO)	Sec
241	0205402A	Integrated Base Defense - Operational System Dev	07						U
242	0205410A	Materials Handling Equipment	07						U
243	0205412A	Environmental Quality Technology - Operational System Dev	07	259				259	U
244	0205456A	Lower Tier Air and Missile Defense (AMD) System	07	166				166	U
245	0205778A	Guided Multiple-Launch Rocket System (GMLRS)	07	75,575				75,575	U
246	0208053A	Joint Tactical Ground System	07	9,510				9,510	U
248	0303028A	Security and Intelligence Activities	07			23,367	23,367	23,367	U
249	0303140A	Information Systems Security Program	07	29,270				29,270	U
250	0303141A	Global Combat Support System	07	86,908				86,908	U
251	0303142A	SATCOM Ground Environment (SPACE)	07	18,684				18,684	U
252	0303150A	WWMCCS/Global Command and Control System	07						U
255	0305172A	Combined Advanced Applications	07						U
256	0305179A	Integrated Broadcast Service (IBS)	07	467				467	U
257	0305204A	Tactical Unmanned Aerial Vehicles	07	4,051		34,100	34,100	38,151	U
258	0305206A	Airborne Reconnaissance Systems	07	13,283		15,575	15,575	28,858	U
259	0305208A	Distributed Common Ground/Surface Systems	07	47,204				47,204	U
260	0305219A	MQ-1C Gray Eagle UAS	07						U

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Department of the Army
FY 2021President's Budget
Exhibit R-1 FY 2021 President's Budget
Total Obligational Authority
(Dollars in Thousands)

17 Jan 2020

Appropriation: 2040A Research, Development, Test & Eval, Army

Line No	Program Element Number	Item	Act	FY 2019 (Base + OCO)	FY 2020 Base Enacted	FY 2020 Emergency	FY 2020 OCO Enacted	FY 2020 Total Enacted (Base+Emerg+ OCO)	Sec
261	0305232A	RQ-11 UAV	07	6,180	3,218			3,218	U
262	0305233A	RQ-7 UAV	07	17,863	7,817			7,817	U
263	0307665A	Biometrics Enabled Intelligence	07	6,524	2,000		2,214	4,214	U
264	0708045A	End Item Industrial Preparedness Activities	07	106,766	108,348			108,348	U
265	1203142A	SATCOM Ground Environment (SPACE)	07	9,927	34,169			34,169	U
266	1208053A	Joint Tactical Ground System	07	7,400	7,677			7,677	U
9999	9999999999	Classified Programs		5,955	7,273			7,273	U
		Operational Systems Development		1,721,365	1,844,126		34,168	1,878,294	
267	0608041A	Defensive CYBER - Software Prototype Development	08						U
		Software and Digital Technology Pilot Program							
Total Research, Development, Test & Eval, Army				11,371,268	12,543,435		147,304	12,690,739	

Department of the Army
FY 2021President's Budget
Exhibit R-1 FY 2021 President's Budget
Total Obligational Authority
(Dollars in Thousands)

17 Jan 2020

Appropriation: 2040A Research, Development, Test & Eval, Army

Line No	Program Element Number	Item	Act	FY 2021 Base	FY 2021 OCO for Base Requirements	FY 2021 OCO for Direct War and Enduring Costs	FY 2021 Total OCO	FY 2021 Total (Base + OCO)	Sec
261	0305232A	RQ-11 UAV	07						U
262	0305233A	RQ-7 UAV	07						U
263	0307665A	Biometrics Enabled Intelligence	07						U
264	0708045A	End Item Industrial Preparedness Activities	07	61,012				61,012	U
265	1203142A	SATCOM Ground Environment (SPACE)	07						U
266	1208053A	Joint Tactical Ground System	07						U
9999	9999999999	Classified Programs		3,983				3,983	U
		Operational Systems Development		1,998,539		75,342	75,342	2,073,881	
267	0608041A	Defensive CYBER - Software Prototype Development	08	46,445				46,445	U
		Software and Digital Technology Pilot Program		46,445				46,445	
Total Research, Development, Test & Eval, Army				12,587,343		182,824	182,824	12,770,167	

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Appropriation 2040: Research, Development, Test & Evaluation, Army

Line #	Budget Activity	Program Element Number	Program Element Title	Page
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7	02	0602115A	Biomedical Technology	10
8	02	0602120A	Sensors and Electronic Survivability	14
9	02	0602122A	TRACTOR HIP	24
10	02	0602126A	TRACTOR JACK	27
11	02	0602134A	Counter Improvised-Threat Advanced Studies	28
12	02	0602141A	Lethality Technology	32
13	02	0602142A	Army Applied Research	51
14	02	0602143A	Soldier Lethality Technology	52
15	02	0602144A	Ground Technology	120
16	02	0602145A	Next Generation Combat Vehicle Technology	147
17	02	0602146A	Network C3I Technology	231
18	02	0602147A	Long Range Precision Fires Technology	321
19	02	0602148A	Future Verticle Lift Technology	362
20	02	0602150A	Air and Missile Defense Technology	416
21	02	0602211A	Aviation Technology	439

Appropriation 2040: Research, Development, Test & Evaluation, Army

Line #	Budget Activity	Program Element Number	Program Element Title	Page
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23	02	0602270A	Electronic Warfare Technology	463
24	02	0602303A	Missile Technology	470
25	02	0602307A	Advanced Weapons Technology	476
26	02	0602308A	Advanced Concepts and Simulation	481
27	02	0602601A	Combat Vehicle and Automotive Technology	488
28	02	0602618A	Ballistics Technology	498
29	02	0602622A	Chemical, Smoke and Equipment Defeating Technology	504
30	02	0602623A	Joint Service Small Arms Program	507
31	02	0602624A	Weapons and Munitions Technology	510
32	02	0602705A	Electronics and Electronic Devices	520
33	02	0602709A	Night Vision Technology	532
34	02	0602712A	Countermine Systems	538
35	02	0602716A	Human Factors Engineering Technology	544
36	02	0602720A	Environmental Quality Technology	550
37	02	0602782A	Command, Control, Communications Technology	559
38	02	0602783A	Computer and Software Technology	567
39	02	0602784A	Military Engineering Technology	571

Appropriation 2040: Research, Development, Test & Evaluation, Army

Line #	Budget Activity	Program Element Number	Program Element Title	Page
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41	02	0602786A	Warfighter Technology	593
42	02	0602787A	Medical Technology	603

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Advanced Weapons Technology	0602307A	25	02	476
Air and Missile Defense Technology	0602150A	20	02	416
Army Applied Research	0602142A	13	02	51
Aviation Technology	0602211A	21	02	439
Ballistics Technology	0602618A	28	02	498
Biomedical Technology	0602115A	7	02	10
C3I Applied Cyber	0602213A	22	02	447
Chemical, Smoke and Equipment Defeating Technology	0602622A	29	02	504
Combat Vehicle and Automotive Technology	0602601A	27	02	488
Command, Control, Communications Technology	0602782A	37	02	559
Computer and Software Technology	0602783A	38	02	567
Counter Improvised-Threat Advanced Studies	0602134A	11	02	28
Countermine Systems	0602712A	34	02	538
Electronic Warfare Technology	0602270A	23	02	463
Electronics and Electronic Devices	0602705A	32	02	520
Environmental Quality Technology	0602720A	36	02	550

Program Element Title	Program Element Number	Line #	BA	Page
Future Verticle Lift Technology	0602148A	19	02	362
Ground Technology	0602144A	15	02	120
Human Factors Engineering Technology	0602716A	35	02	544
Joint Service Small Arms Program	0602623A	30	02	507
Lethality Technology	0602141A	12	02	32
Long Range Precision Fires Technology	0602147A	18	02	321
Manpower/Personnel/Training Technology	0602785A	40	02	589
Materials Technology	0602105A	6	02	1
Medical Technology	0602787A	42	02	603
Military Engineering Technology	0602784A	39	02	571
Missile Technology	0602303A	24	02	470
Network C3I Technology	0602146A	17	02	231
Next Generation Combat Vehicle Technology	0602145A	16	02	147
Night Vision Technology	0602709A	33	02	532
Sensors and Electronic Survivability	0602120A	8	02	14
Soldier Lethality Technology	0602143A	14	02	52
TRACTOR HIP	0602122A	9	02	24
TRACTOR JACK	0602126A	10	02	27
Warfighter Technology	0602786A	41	02	593

Program Element Title	Program Element Number	Line #	BA	Page
Weapons and Munitions Technology	0602624A	31	02	510

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	79.432	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	79.432
H7B: *Advanced Materials Initiatives (CA)*	-	55.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	55.000
H84: *Materials*	-	20.102	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	20.102
XW4: *Manufacturing Science*	-	4.330	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.330

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is being realigned with continuity of effort to the following PEs:
* 0602141A Lethality Technology
* 0602143A Soldier Lethality Technology
* 0602144A Ground Technology
* 0602145A Next Generation Combat Vehicle Technology

A. Mission Description and Budget Item Justification

This PE conducts fundamental research relevant to the soldier focused on new materials, properties and phenomena in four research areas: (1) lightweight materials and hybrid assemblies for enhanced expeditionary operations, (2) materials and mechanisms that mitigate effects from blast and ballistic threats, (3) materials for augmented soldier protection and situational awareness, and (4) multifunctional materials with integrated structure, power storage, communications, sensing, and/or propulsion to provide system level efficiencies. This PE also funds collaborative applied research and integration of government, academic, and industry scientific research to advance innovative capabilities.

This PE sustains Army science and technology efforts supporting the Soldier portfolio.

Work in this PE builds on the materials research transitioned from PE 0601102A (Defense Research Sciences) and 0601104A (University and Industry Research Centers). This work complements and is fully coordinated with PE 0602618A (Ballistics Technology), PE 0602786A (Warfighter Technology), and PE 0603001A (Warfighter 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.

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	**Date:** February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*

B. Program Change Summary ($ in Millions)	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**
Previous President's Budget	83.586	0.000	0.000	-	0.000
Current President's Budget	79.432	0.000	0.000	-	0.000
Total Adjustments	-4.154	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-3.674	-			
• SBIR/STTR Transfer	-0.480	-			

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2019**	**FY 2020**
Project: H7B: *Advanced Materials Initiatives (CA)*		
Congressional Add: *Program Increase - High Performance Composite Materials*	5.000	-
Congressional Add: *Program Increase - High Performance Polymers Research*	19.916	-
Congressional Add: *Program Increase - Highly Durable Advanced Polymers for Lightweight Armor*	5.000	-
Congressional Add: *Program Increase - Materials Research for Affordability, Performance, and Environmental Sustainability*	10.000	-
Congressional Add: *Program Increase - Advanced Materials Processing*	10.000	-
Congressional Add: *Program Increase - Advanced Polymers*	5.000	-
Congressional Add: *FY 2018 NDAA SEC 825 MDAP Cost Overrun*	0.084	-
Congressional Add Subtotals for Project: H7B	55.000	-
Congressional Add Totals for all Projects	55.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** H7B / *Advanced Materials Initiatives (CA)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H7B: *Advanced Materials Initiatives (CA)*	-	55.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	55.000

Note

Congressional increase.

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Advanced Materials Initiatives.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Program Increase - High Performance Composite Materials ***FY 2019 Accomplishments:*** Program Increase - High Performance Composite Materials	5.000	-
Congressional Add: Program Increase - High Performance Polymers Research ***FY 2019 Accomplishments:*** Program Increase - High Performance Polymers Research	19.916	-
Congressional Add: Program Increase - Highly Durable Advanced Polymers for Lightweight Armor ***FY 2019 Accomplishments:*** Program Increase - Highly Durable Advanced Polymers for Lightweight Armor	5.000	-
Congressional Add: Program Increase - Materials Research for Affordability, Performance, and Environmental Sustainability ***FY 2019 Accomplishments:*** Program Increase - Materials Research for Affordability, Performance, and Environmental Sustainability	10.000	-
Congressional Add: Program Increase - Advanced Materials Processing ***FY 2019 Accomplishments:*** Program Increase - Advanced Materials Processing	10.000	-
Congressional Add: Program Increase - Advanced Polymers ***FY 2019 Accomplishments:*** Program Increase - Advanced Polymers	5.000	-
Congressional Add: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***FY 2019 Accomplishments:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.084	-
Congressional Adds Subtotals	55.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** H7B / *Advanced Materials Initiatives (CA)*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** H84 / *Materials*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H84: *Materials*	-	20.102	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	20.102

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
Program Element (PE) 0602141A Lethality Technology)
* Project AH8 Lethality Materials and Processes Technology
PE 0602143A Soldier Lethality Technology
* Project AZ5 Soldier Protection Technology - Vulnerability
* Project BE6 Reactive/Resp Surfaces & Matls - Soldiers & Sys
PE 0602145A Next Generation Combat Vehicle Technology
* Project BI4 Materials Application and Integration Tech

A. Mission Description and Budget Item Justification

This Project designs, fabricates, and evaluates a variety of materials (e.g. metals, ceramics, polymers, and composites) that have potential to enable more survivable, lighter weight soldier and vehicle armor, chemical and biological protection, armaments, and electronics. Research conducted focuses on unique and/or novel material properties, developing physics-based models, materials characterization techniques, non-destructive testing methods and advanced fabrication/processing methodologies.

This Project sustains Army science and technology efforts supporting the Ground Maneuver, Lethality, and Soldier portfolios.

Work in this Project makes extensive use of high performance computing and experimental validation and builds on research transitioned from PE 0601102A (Defense Research Sciences), Project H42 (Materials and Mechanics), and Project H43 (Research In Ballistics). The work complements and is fully coordinated with efforts in PE 0602601A (Combat Vehicle and Automotive Technology), PE 0602618A (Ballistic Technology), PE 0602786A (Warfighter Technology), PE 0603001A (Warfighter Advanced Technology), PE 0603004A (Weapons and Munitions Advanced Technology), PE 0603005A (Combat Vehicle and Automotive Advanced Technology), and PE 0708045A (Manufacturing Technology).

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Structural Armor Materials	3.899	-	-
Description: Conduct applied research to design and evaluate lightweight armor materialsand structures, investigate novel processing methodologies for cost effective manufacturing, use existing and emerging modeling and simulation tools to enable formulation of lightweight, frontal, and structural armor materials for current and future platform applications. Explore ground			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** H84 / *Materials*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
vehicle structural mechanics and dynamics technologies to improve damage tolerance, durability, fatigue-resistance, and dynamic response (shock, vibration, harshness, and damping).			
Title: Soldier-Borne Armor Materials ***Description:*** Utilizing understanding of defeat mechanisms from PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) conduct applied research of emerging lightweight armor materials and structures to enable affordable design of multifunctional ballistic protective systems for the future Soldier. Provide quantitative scientific basis for modeling and simulation that result in materials that utilize new lethal mechanisms/protection schemes for the individual Warfighter.	4.842	-	-
Title: Lethality Materials Technology ***Description:*** This effort involves applied research to develop innovative materials solutions aimed at achieving leap-ahead increases in lethality and weapons effectiveness through dramatic improvements in weight and volume efficiency, lethal effects, and sustainability of military systems that can only be achieved through advances in materials technology.	3.764	-	-
Title: Multifunctional Armor Materials ***Description:*** This effort researches novel multifunctional armor materials and associated processing science aimed at enabling critical Army applications in survivability and sustainment. Research efforts include multifunctional protective films and coatings, joining of dissimilar materials, and additive manufacturing of multifunctional materials. Soldier personnel protection materials transition to PE 0602786A (Warfighter Technology) / Project H98 (Clothing and Equipment Technology). Vehicle armor materials transition to PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) and PE 0602601A (Combat Vehicle and Automotive Technology) / Project C05 (Armor Applied Research).	2.415	-	-
Title: Nanomaterials ***Description:*** Mature and scale-up nanomaterials processes, fabrication, characterization and performance measures to enable revolutionary concepts for future force lethality and survivability beyond those addressed for individual Soldier protection in PE 0602105A (Materials Technology) / Project H7G (Nanomaterials Applied Research).	2.018	-	-
Title: Bio-enabled Materials and Processes ***Description:*** Fundamental research through the application of biotechnology advances to develop materials with capabilities to respond and adapt to a wide range of external stimuli and biological processes.	3.133	-	-
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***Description:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.031	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** H84 / *Materials*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Accomplishments/Planned Programs Subtotals	20.102	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** XW4 / *Manufacturing Science*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
XW4: *Manufacturing Science*	-	4.330	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.330

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
Program Element (PE) 0602144A Ground Technology
* Project BL1 Materials and Manufacturing Research Technology

A. Mission Description and Budget Item Justification

This Project links materials research, manufacturing processes, and design to enable rapid development and certification of lightweight, multifunctional materials technologies for protection, maneuver, and situational awareness. Research conducted enables new manufacturing capabilities through the development of high performance feedstock materials (polymers, metals, and ceramics), physics-based process models, and in situ process monitoring that can be integrated with process models to enable real-time control and manipulation of materials structure and properties. The goal of this work is to develop robust predictive model and simulation tools linking manufacturing processes with materials structure, properties, and performance to accelerate the rate of innovative material adaptations (protection, power, sensing, and signature management) necessary to rapidly respond to emerging and unknown threats in a battlefield environment.

This Project sustains Army science and technology efforts supporting the Ground Maneuver, Lethality, and Soldier portfolios.

Work in this Project makes extensive use of high performance computing and experimental validation and builds on research transitioned from PE 0601102A (Defense Research Sciences) / Project H42 (Materials and Mechanics), and Project H43 (Research In Ballistics). The work complements and is fully coordinated with efforts in PE 0602105A (Materials Technology), PE 0602601A (Combat Vehicle and Automotive Technology), PE 0602618A (Survivability and Lethality Technologies), PE 0602786A (Warfighter Technology), PE 0603001A (Warfighter Advanced Technology), PE 0603004A (Weapons and Munitions Advanced Technology), PE 0603005A (Combat Vehicle Advanced Technology), and PE 0708045A (Manufacturing Technology).

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Agile Expedient Manufacturing	4.323	-	-
Description: Conduct applied research to develop innovative materials technologies that enable new protection, power, sensing, and signature management capabilities utilizing additive manufacturing and related methods to rapidly respond to emerging and unknown threats in a battlefield environment. Efforts include the development of new feedstock materials, engineered specifically for low-volume additive processes to produce net-shape materials with desired properties and functionalities, new processing capabilities that revolutionize additive manufacturing and enable production of lightweight materials systems for protection and maneuverability that cannot be produced through traditional manufacturing methods, integrated process models and real-time			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** XW4 / *Manufacturing Science*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
monitoring for closed-loop control and optimal production of lightweight materials, and abilities to design and produce optimal materials at the point of need using available materials, energy sources, etc.			
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***Description:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.007	-	-
Accomplishments/Planned Programs Subtotals	4.330	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602115A / *Biomedical Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	0.000	0.000	11.835	-	11.835	12.072	12.313	12.559	12.805	0.000	61.584
EB2: *HIV Biomedical Technology*	-	0.000	0.000	11.835	-	11.835	12.072	12.313	12.559	12.805	0.000	61.584

Note

This is a new start in FY2021.

This Program Element (PE) is a New Start for Fiscal Year 2021 (FY21).

A. Mission Description and Budget Item Justification

This PE funds the Military Human Immunodeficiency Virus (HIV) Research Program and the Combatting Antimicrobial Resistant Bacteria (CARB) projects. The goal of the Military HIV Research Program is to refine identification methods for determining genetic diversity of the virus, to conduct preclinical work in laboratory animals including non-human primates to identify candidates for global HIV-1 vaccine, and to evaluate and prepare overseas sites for clinical trials with these vaccine candidates. For the CARB program, funding provides for the development of strategies to prevent, mitigate, and treat antibiotic resistant bacteria in wounds through the CARB - Walter Reed Army Institute of Research (WRAIR) Discovery and Wound Program.

In FY21 these programs were transferred from the Defense Health Agency to the United States Army.

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	0.000	0.000	0.000	-	0.000
Current President's Budget	0.000	0.000	11.835	-	11.835
Total Adjustments	0.000	0.000	11.835	-	11.835
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	11.835	-	11.835

Change Summary Explanation

In FY21, funding was transferred to the Army from the Defense Health Program (DHP) Research, Development, Test, and Evaluation (RDTE) Program Elements 0602115DHA Projects 246A and 447A.

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602115A / *Biomedical Technology*	Project (Number/Name) EB2 / *HIV Biomedical Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
EB2: *HIV Biomedical Technology*	-	0.000	0.000	11.835	-	11.835	12.072	12.313	12.559	12.805	0.000	61.584

Note

This is a new start in FY2021.

In Fiscal Year 2021 this is a New Start.

A. Mission Description and Budget Item Justification

The Military Human Immunodeficiency Virus (HIV) Research Program conducts research on HIV, which causes acquired immunodeficiency syndrome (AIDS). Work in this area includes refining improved identification methods to determine genetic diversity of the virus and evaluating and preparing overseas sites for clinical trials with global vaccine candidates. Additional activities include refining candidate vaccines for preventing HIV and undertaking preclinical studies (studies required before testing in humans) to assess vaccine for potential to protect and/or manage the disease in infected individuals. This project is jointly managed through an Interagency Agreement between U.S. Army Medical Research and Development Command (USAMRDC) and the National Institute of Allergy and Infectious Diseases (NIAID) of the National Institutes of Health.

The Combatting Antimicrobial Resistant Bacteria (CARB) research program was established in response to Presidential direction in late 2013 to create a National Strategy to address the critical issue of antimicrobial resistance. This effort's focus is on the development of new/novel antibiotics, especially those targeting the most resistant and worrisome Gram negative bacterial pathogens, using existing expertise at the Walter Reed Army Institute of Research (WRAIR), and leveraging other WRAIR capabilities to evaluate viable candidate targets for advanced discovery. This project supports (both directly and indirectly) Global Health Security Agenda priorities to respond rapidly and effectively to biological threats of international concern.

The cited work is also consistent with the Assistant Secretary of Defense, Research and Engineering Science and Technology focus areas, and supports the principal area of Military Relevant Infectious Diseases to include HIV.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: HIV Biomedical Technology	-	-	9.847
Description: The Military HIV Research Program conducts research on HIV, which causes AIDS. Work in this area includes refining improved identification methods to determine genetic diversity of the virus and evaluating and preparing overseas sites for future vaccine trials. Additional activities include refining candidate vaccines for preventing HIV and undertaking preclinical studies (studies required before testing in humans) to assess vaccine for potential to protect and/or manage the disease in infected individuals.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602115A / *Biomedical Technology*	**Project (Number/Name)** EB2 / *HIV Biomedical Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
The Military HIV Research Program will produce and characterize new vaccine candidates for use in pre-clinical and clinical testing. Vaccine candidates will be evaluated to assess their ability to invoke an immune response in non-human primates by using novel delivery systems containing a diverse mixture of antigens (substance that induces an immune response) for HIV subtypes A, B, C, D and E. The program will develop and optimize methods of large scale production of new vaccine candidates for testing in Africa and Asia to assess candidate vaccines against diverse HIV subtypes. Efforts will continue to identify and develop new clinical trial sites in Europe, Southeast Africa, Asia and the US in order to allow scientists the opportunity to test future vaccine candidates against predominant HIV subtypes circulating around the world. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred from the Defense Health Program (DHP) Research, Development, Test and Evaluation (RDTE) Program Element 0602115DHA Project 447A			
Title: Combatting Antimicrobial Resistant Bacteria ***Description:*** The CARB research program focus is to establish in-house capabilities for an antibacterial drug discovery program directed toward military relevant drug-resistant bacteria that a) encompasses assessment of external products/candidates/leads that may meet DoD requirements, b) opens active intramural based discovery efforts of new potential products/candidates/ leads for development, and c) fosters partnerships with external collaborators to develop/co-develop new potential antibacterial treatment therapeutics. ***FY 2021 Plans:*** The CARB program will continue its research efforts to evaluate viable small molecule candidate antibacterial agents for planned development for the Department of Defense (DoD) and Public Health benefit. In addition, the program will continue its market analysis of established, non-DoD antibiotic programs to identify other promising compounds that could potentially treat military relevant resistant bacteria, establishing partnership and intellectual property rights agreements where necessary. These promising compounds will be screened against military relevant strains and biofilms (microorganisms in which cells stick to each other on a surface) in order to select compounds for continued development. Specifically designed novel drugs will be synthesized to support lead optimization efforts, exploiting established in vivo (living organism) model standards to treat military relevant resistant bacteria. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred from the Defense Health Program (DHP) RDTE Program Element 0602115DHA Projects 246A	-	-	1.988
Accomplishments/Planned Programs Subtotals	-	-	11.835

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602115A / *Biomedical Technology*	**Project (Number/Name)** EB2 / *HIV Biomedical Technology*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	90.023	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	90.023
H16: *S3I Technology*	-	28.972	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	28.972
SA1: *Sensors and Electronic Initiatives (CA)*	-	48.500	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	48.500
TS1: *Tactical Space Research*	-	3.416	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.416
TS2: *Robotics Technology*	-	9.135	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	9.135

Note

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

A. Mission Description and Budget Item Justification

This PE investigates designs and evaluates sensors and electronic components and software that enhance situational awareness, survivability, lethality, and autonomous mobility for tactical ground forces. Project H16 investigates sensors, signal processing and information fusion technologies to increase target detection range and speed of engagement. Project SA1 (Congressional Interest Item) focuses on the design and development of Assured Positioning, Navigation, and Timing, and Robust Communications technologies for the Warfighter in disadvantaged/degraded environments. Project SA2 conducts applied research on biological sensors and biologically derived electronics that exploits breakthroughs in biotechnology basic research in collaboration with the Institute for Collaborative Biotechnology (ICB), a University Affiliated Research Center (UARC) led by the University of California, Santa Barbara in partnership with California Institute of Technology and Massachusetts Institute of Technology and their industry partners. Project TS1 researches and evaluates space-based remote sensing, signal, and information processing software in collaboration with other Department of Defense (DoD) and government agencies to support space force enhancement and space superiority advanced technology integration into Army battlefield operating systems. Project TS2 focuses on advancing perception for autonomous ground mobility, intelligent vehicle control and behaviors, human-robot interaction, robotic manipulation, and unique mobility for unmanned vehicles.

Work in this PE complements and is fully coordinated with efforts in PE 0602307A (Advanced Weapons Technology), PE 0602705A (Electronics and Electronic Devices), PE 0602709A (Night Vision Technology), PE 0602782A (Command, Control, Communications Technology), PE 0603001A (Warfighter Advanced Technology), PE 0603006A (Command, Control, Communications Advanced Technology), PE 0603710A (Night Vision Advanced Technology), and PE 0603772A (Advanced Tactical Computer Science and Sensor Technology),

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	**Date:** February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*

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

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

B. Program Change Summary ($ in Millions)	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**
Previous President's Budget	80.849	0.000	0.000	-	0.000
Current President's Budget	90.023	0.000	0.000	-	0.000
Total Adjustments	9.174	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	9.735	-			
• SBIR/STTR Transfer	-0.561	-			

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2019**	**FY 2020**
Project: SA1: *Sensors and Electronic Initiatives (CA)*		
Congressional Add: *Advanced Space Data Exp & Integ*	9.500	-
Congressional Add: *Agile Manufacturing Materials Processing (CCDC)*	14.980	-
Congressional Add: *Tactical Space-Small Sat Tech Dev*	20.000	-
Congressional Add: *Open Campus Initiative (CCDC)*	4.000	-
Congressional Add: *FY 2018 NDAA SEC 825 MDAP Cost Overrun (CCDC)*	0.020	-
Congressional Add Subtotals for Project: SA1	48.500	-
Congressional Add Totals for all Projects	48.500	-

Change Summary Explanation

FY 2019 increase of $9.735M in support of Army modernization efforts (Project H16/Networked Sensing and Data Fusion).

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** H16 / *S3I Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H16: *S3I Technology*	-	28.972	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	28.972

Note

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

A. Mission Description and Budget Item Justification

This Project designs, investigates, evaluates, and characterizes advanced sensor components, signal processing, and information fusion algorithms that will provide the future Soldier decisive new capabilities to locate, identify, and make decisions about and engage battlefield targets in tactical environments. The ultimate impact and utility of this work will be to greatly increase the lethality, range, and speed of engagement of the Soldier. Emphasis is on solving critical Army-specific battlefield sensing and information management problems, such as false targets, complex terrain (including urban applications), movement of sensors on military vehicles, and exploitation of multimodal sensors. Significant areas of research include low-cost networked sensors for force protection, hostile fire defeat, homeland defense, counter terrorism operations, munitions, and fusion of disparate sensors (e.g., acoustic, seismic, electric-field (E-field), magnetic field) to passively detect, classify, and track battlefield targets such as personnel, heavy/light vehicles, and helicopters. Other areas of research include sensing technologies for tagging, tracking, and locating (TTL) non-traditional targets and the location of direct and indirect fires and other hostile threats. Further areas of research include ultraviolet (UV) optoelectronics for battlefield sensors, networked compact radar for vehicle and dismount identification and tracking; ultra-wideband radar for buried and concealed threat detection, enhanced robotic mobility, stand-off characterization of infrastructure, and the detection, classification, and tracking of humans in urban terrain. Additional areas of research are aided/ automatic target recognition (ATR), advanced battlefield sensor and information processing to conduct a dynamic and real time situational assessment to present a common picture of the battle space focused on low echelon commanders; protection of sensors, especially human eyes, from battlefield laser threats; and advanced computational methods to provide automatic information technologies from widely dispersed sensor and legacy information sources for improved situational awareness.

This Project supports Army Science and Technology efforts in the Command, Control, Communications and Intelligence, Ground, and Soldier portfolios. The sensor-related work in this Project complements efforts funded in PE 0601104A (University and Industry Research Centers), PE 0602709A (Night Vision Technology), PE 0603710A (Night Vision Advanced Technology), and PE 0603001A (Warfighter Advanced Technology). The networked sensing and data fusion efforts performed in this

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** H16 / *S3I Technology*

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Non-Imaging Intelligence, Surveillance, and Reconnaissance (ISR) Sensing ***Description:*** This effort designs and characterizes technologies for multi-modal (acoustic, seismic, infrasound, electric and magnetic (E/H) field, and passive radio frequency (RF)), low-cost networked sensors to enhance persistent sensing capabilities for increased probability of target detection and reduced false alarms. These combined sensors have unique capabilities that enable detection of electrical equipment operation, underground facilities, vehicles, weapons launch, gunfire, and explosions.	6.169	-	-
Title: Networked Sensing and Data Fusion ***Description:*** This effort will develop and assess a concept to link physical sensors and information sources to Soldiers and small units. Specifically, the research focuses on (1) multi-modal sensor fusion for detection and classification of human activities and infrastructures such as personnel, vehicles, machinery, RF emissions, chemicals, and computers in hidden and confined spaces, (2) interoperability and networking of disparate sensors and information sources, (3) distributed information for decision-making, and (4) approaches for fusing results of processed outputs of multi-modal sensors, such as visible, infrared (IR), and hyperspectral imagers, and acoustic, magnetic, and electric field sensors.	14.252	-	-
Title: RF Sensing for Concealed/Low-Signature Threat Detection ***Description:*** This effort develops the technical underpinnings of ultra-wideband (UWB) radar and other active and passive RF sensing modalities for several key Army concealed and low-signature target detection requirements, including landmine and improvised explosive device (IED) detection, sensing through-the-wall, foliage penetration, unmanned aerial system (UAS) detection, other electronic threat detection, and obstacle avoidance for autonomous navigation. This research uses a combination of advanced computational electromagnetic models and algorithms, radar measurements, active and passive RF sensing technologies, and advanced signal processing techniques to define the performance boundaries of state-of-the-art airborne and ground-based UWB radar and other RF sensing modalities for concealed and low-signature target detection and classification.	2.967	-	-
Title: Laser Protection Technologies ***Description:*** This effort develops new materials and devices for the protection of Army sensors and eyes behind day-view optical sights from a variety of laser threats including high-power continuous wave and ultrashort (femto-second) pulsed lasers. This research utilizes a combination of technologies based on the nature of the different threats, as well as the fundamental	5.054	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** H16 / *S3I Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
differences in sensors operating over different frequency ranges. Passive organic and inorganic optical limiter materials that block specific frequency bands of light will be investigated and developed for the visible and short-wave infrared (SWIR) spectrum, and active man-made material-based solutions will be investigated for uncooled sensors in the long-wave IR (LWIR). Vulnerability of sensors and optical sensor systems will be studied against high-power and ultrashort pulsed laser threats to determine protection requirements.			
Title: Multi-Mode Air Defense Radar ***Description:*** This research supports the current and future technical challenges associated with air defense radar technology. In particular, this effort will analyze current and emerging RF spoofing, RF jamming, and RF signature management technologies to determine their impact on the performance of air defense radars. Electromagnetic modeling, RF measurements, and experiments will be used to identify mitigation techniques for spoofing and jamming, and to identify useful signature management technologies. This will also include research in electronic devices, sub-assembly design, and laboratory experiments to advance the state-of-the-art of air defense radars operating in contested electronic environments.	0.500	-	-
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***Description:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.030	-	-
Accomplishments/Planned Programs Subtotals	28.972	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** SA1 / *Sensors and Electronic Initiatives (CA)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
SA1: *Sensors and Electronic Initiatives (CA)*	-	48.500	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	48.500

Note

Congressional add

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Sensors and Electronic Initiatives.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Advanced Space Data Exp & Integ ***FY 2019 Accomplishments:*** Advanced Space Data Exp & Integ	9.500	-
Congressional Add: Agile Manufacturing Materials Processing (CCDC) ***FY 2019 Accomplishments:*** Agile Manufacturing Materials Processing (CCDC)	14.980	-
Congressional Add: Tactical Space-Small Sat Tech Dev ***FY 2019 Accomplishments:*** Tactical Space-Small Sat Tech Dev	20.000	-
Congressional Add: Open Campus Initiative (CCDC) ***FY 2019 Accomplishments:*** Open Campus Initiative (CCDC)	4.000	-
Congressional Add: FY 2018 NDAA SEC 825 MDAP Cost Overrun (CCDC) ***FY 2019 Accomplishments:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun (CCDC)	0.020	-
Congressional Adds Subtotals	48.500	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** TS1 / *Tactical Space Research*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
TS1: *Tactical Space Research*	-	3.416	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.416

Note

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

A. Mission Description and Budget Item Justification

This Project researches, evaluates, and adapts technologies for space-based and high altitude applications for Army tactical ground forces. Applied research efforts include the design and development of sensors and electronic components for communications, signal and information processing, target acquisition, position/navigation, and threat warning within space and high altitude environments. The applied research and technology evaluations conducted under this Project leverage other Department of Defense (DoD) space science and technology applications to support Army space force enhancement and cooperative satellite payload development.

Work in this Project complements and is fully coordinated with PE 0603006A (Command, Control, Communications Advanced Technology).

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Tactical Space Research ***Description:*** This effort designs, develops, and evaluates space-based technologies, components, and tools that lead to smaller, lighter, more responsive payloads and applications. These technologies allow for the rapid integration and development of tactical payloads in support of responsive space environments. Work related to standard Army networks is done in coordination with the Communications-Electronics Research Development and Engineering Center (CERDEC) and Army Cyber Center of Excellence.	2.289	-	-
Title: Space and Analysis Lab ***Description:*** This effort provides an in-house capability to design and conduct analytic evaluations of space and high altitude technologies.	1.127	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** TS1 / *Tactical Space Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Accomplishments/Planned Programs Subtotals	3.416	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** TS2 / *Robotics Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
TS2: *Robotics Technology*	-	9.135	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	9.135

Note

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

A. Mission Description and Budget Item Justification

This Project designs, evaluates, and investigates autonomous technologies to enable robotics to assist military missions. Technical efforts are focused on advancing perception for autonomous ground and air mobility, intelligent vehicle control and behaviors, human-robot interaction, robotic manipulation, and improved mobility for unmanned vehicles of scales from micro-systems through tactical combat vehicles. The Project provides the underpinning research of the Robotics Collaborative Technology Alliance (CTA), a cooperative arrangement with industry and academia to conduct a concerted, collaborative effort advancing key enabling robotic technologies required for future unmanned systems. The Robotics CTA research is funded in PE0601104A (University and Industry Research Centers) / Project H09 (Robotics CTA).

This Project leverages basic research conducted under PE 0601102A (Defense Research Sciences) / Project T63 (Robotics Autonomy, Manipulation and Portability Rsh) and PE 0601104A (University and Industry Research Centers / Project H09 (Robotics CTA) and transitions knowledge and emerging technologies to PE 0603005A (Combat Vehicle and Automotive Advanced Technology) for maturation and demonstration.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering focus areas, and the Army Modernization Strategy. The Ground Portfolio technology investments are improving logistics throughput and surge capability supporting maneuver forces (Leader-Follower technology) and allow experimentation with manned and unmanned teams to develop the advantages that inform/protect the maneuver force.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Robotics CTA	3.207	-	-
Description: Conduct applied research to provide essential capabilities for advanced perception, intelligent control and tactical behavior, human-robot interaction, robotic manipulation, and unique mobility for unmanned systems to conduct multiple military missions for a full range of robots from man-portable to larger systems. Research focuses on new sensor and sensor processing algorithms for rapid detection and classification of objects in cluttered and unknown environments, enabling autonomous mobility and intelligent tactical behavior by future unmanned systems; implementing adaptive control strategies that will enable unmanned systems to display intelligent tactical behavior, formulation of control strategies that will facilitate use of unmanned systems in			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** TS2 / *Robotics Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
populated environments and minimize the cognitive workload on Soldier operators enabling more dexterous manipulation of objects.			
Title: Perception and Intelligent Control ***Description:*** Advance perception and intelligent control technologies required to achieve autonomous tactical behaviors, based on the environment, and other objective capabilities for future unmanned vehicles of multiple size scales and to transition this technology to advanced development programs being conducted under PE 0603005A (Combat Vehicle and Automotive Advanced Technology) / Project 515 (Robotic Ground Systems) for integration into test bed systems.	4.500	-	-
Title: Ground Robotic Vehicle Mobility and Propulsion Technology ***Description:*** Advance the speed and agility of unmanned vehicles in complex three-dimensional environments through exploration of advanced and unconventional mobility and propulsion technologies integrated with innovative application of perceptual and reasoning capabilities. Ground robotic platforms may have legs, may be able to climb or may even be robots restricted to small confined spaces. Research will focus on developing actuation mechanism that intelligently achieve movement while minimizing the use of energy to ensure longer range and endurance of the system.	1.418	-	-
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***Description:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.010	-	-
Accomplishments/Planned Programs Subtotals	9.135	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602122A / *TRACTOR HIP*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	8.674	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	8.674
622: *D622*	-	3.840	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.840
B72: *AB72*	-	4.834	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.834

Note

The details of this program are reported in accordance with Title 10, United States Code, Section 119(a)(1).

A. Mission Description and Budget Item Justification

The details of this program are reported in accordance with Title 10, United States Code, Section 119(a)(1).

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	8.674	0.000	0.000	-	0.000
Current President's Budget	8.674	0.000	0.000	-	0.000
Total Adjustments	0.000	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			

Change Summary Explanation

The details of this program are reported in accordance with Title 10, United States Code, Section 119(a)(1).

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602122A / *TRACTOR HIP*	Project (Number/Name) 622 / *D622*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
622: *D622*	-	3.840	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.840

A. Mission Description and Budget Item Justification

The details of this program are reported in accordance with Title 10, United States Code, Section 119(a)(1).

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602122A / *TRACTOR HIP*	Project (Number/Name) B72 / *AB72*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
B72: *AB72*	-	4.834	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.834

A. Mission Description and Budget Item Justification

The details of this program are reported in accordance with Title 10, United States Code, Section 119(a)(1).

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602126A / *TRACTOR JACK*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	0.400	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.400
XW8: *TRACTOR JACK*	-	0.400	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.400

A. Mission Description and Budget Item Justification

The details of this program are reported in accordance with Title 10, United States Code, Section 119(a)(1).

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	0.400	0.000	0.000	-	0.000
Current President's Budget	0.400	0.000	0.000	-	0.000
Total Adjustments	0.000	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			

Change Summary Explanation

The details of this program are reported in accordance with Title 10, United States Code, Section 119(a)(1).

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602134A / *Counter Improvised-Threat Advanced Studies*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	0.000	0.000	2.000	-	2.000	2.000	2.000	2.000	2.000	0.000	10.000
CD2: *Counter Improvised-Threat Advanced Studies*	-	0.000	0.000	2.000	-	2.000	2.000	2.000	2.000	2.000	0.000	10.000

Note

This is a new start in FY2021.

This Program Element is a New Start for Fiscal Year 2021 (FY21).

A. Mission Description and Budget Item Justification

This Program Element (PE) executes applied research into novel methods for detecting and defeating Improvised Explosive Devices (IED) through the application of emerging technologies as well as research into emerging IED threats to evaluate potential methods of defeat. The goal of this research is to increase the ability of deployed forces to positively identify IEDs with minimal false alarms and positively neutralize or mitigate the effects of IEDs with minimal collateral damage through the systematic identification and maturation of technologies capable of defeating IEDs.

This PE is executed by the Army Futures Command (AFC) in coordination with the Under Secretary of Defense for Research and Engineering (USD/R&E) and the Defense Threat Reduction Agency (DTRA).

Work in this PE was previously conducted under PE 0602134BR, Improvised Threat Reduction Applied Research.

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	0.000	0.000	0.000	-	0.000
Current President's Budget	0.000	0.000	2.000	-	2.000
Total Adjustments	0.000	0.000	2.000	-	2.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	2.000	-	2.000

Exhibit R-2, **RDT&E Budget Item Justification:** PB 2021 Army	**Date:** February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602134A / *Counter Improvised-Threat Advanced Studies*

Change Summary Explanation

This PE is realigned in FY21 from PE 0602134BR Improvised Threat Reduction Applied Research as a result of the transfer of Counter-IED (C-IED) Research, Development, Test, and Evaluation (RDTE) activities to the Army and is fully coordinated with the Under Secretary of Defense for Research and Engineering (USD/R&E) and Defense Threat Reduction Agency (DTRA).

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602134A / *Counter Improvised-Threat Advanced Studies*	**Project (Number/Name)** CD2 / *Counter Improvised-Threat Advanced Studies*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
CD2: *Counter Improvised-Threat Advanced Studies*	-	0.000	0.000	2.000	-	2.000	2.000	2.000	2.000	2.000	0.000	10.000

Note

This is a new start in FY2021.

This Project is a New Start for Fiscal Year 2021 (FY21).

A. Mission Description and Budget Item Justification

This Project researches novel methods for detecting and defeating Improvised Explosive Devices (IED) as well as research into emerging IED threats to evaluate potential methods of defeat.

This Project is executed by the Army Futures Command (AFC) in coordination with the Under Secretary of Defense for Research and Engineering (USD/R&E) and the Defense Threat Reduction Agency (DTRA).

Work in this Project was previously conducted under PE 0602134BR, Improvised Threat Reduction Applied Research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Counter IED Emerging Technologies	-	-	2.000
Description: This effort investigates emerging technologies to include physics, chemistry, biology and computer science to identify applications to detect current and emerging IED threats and defeat their critical components. This effort investigates novel methods and technology solutions for the detection and defeat of IEDs through the systematic identification and maturation of technologies capable of defeating these threats. The goals include increasing the distance for standoff detection, improving the probability of positive identification and reducing the rate of false indications. This effort is informed by technology trends across the Department of Defense and by analysis of IED threats encountered in operational scenarios.			
FY 2021 Plans: Will investigate emerging technologies to include physics, chemistry, biology and computer science to identify novel techniques to detect current and emerging IED threats and defeat their critical components. Will evaluate multiple technologies to assess their ability to counter IED threats in laboratory environments and transition promising technologies to PE 0603134BR Counter Improvised-Threat Simulation, Project CD3 Counter Improvised-Threat Simulation.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602134A / *Counter Improvised-Threat Advanced Studies*	**Project (Number/Name)** CD2 / *Counter Improvised-Threat Advanced Studies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
This effort is a transfer from PE 0602134BR Counter Improvised-Threat Applied Research, as a result of the transfer of Counter-IED (C-IED) Research, Development, Test, and Evaluation (RDTE) activities to the Army.			
Accomplishments/Planned Programs Subtotals	-	-	2.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	0.000	69.961	42.425	-	42.425	45.824	45.587	46.013	44.071	0.000	293.881
AH5: *Projectile and Multi-Function Warhead Technologies*	-	0.000	3.446	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.446
AH6: *Disruptive Energetics and Propulsion Technologies*	-	0.000	8.275	8.432	-	8.432	8.602	8.775	8.874	8.874	0.000	51.832
AH7: *Lethal and Scalable Effects Technologies*	-	0.000	1.869	1.057	-	1.057	1.954	1.328	1.540	1.540	0.000	9.288
AH8: *Lethality Materials and Processes Technology*	-	0.000	3.954	4.046	-	4.046	4.109	4.026	4.071	4.112	0.000	24.318
AH9: *Advanced Warheads Technology*	-	0.000	9.417	23.802	-	23.802	27.069	27.610	29.416	29.545	0.000	146.859
AI1: *Advanced Terrain Shaping Technology*	-	0.000	0.000	5.088	-	5.088	4.090	3.848	2.112	0.000	0.000	15.138
BS6: *Lethality Technology (CA)*	-	0.000	43.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	43.000

Note

In Fiscal Year 2020 (FY20), funding in this Program Element (PE) was realigned with continuity of effort from the following PEs:
* 0602105A Materials Technology
* 0602618A Ballistics Technology
* 0602624A Weapons and Munitions Technology

A. Mission Description and Budget Item Justification

Work done in this PE researches technologies, methodologies, and models required to enable next generation lethality. The effort focuses on: lethal mechanism technologies for projectiles and warheads that provide revolutionary capability to defeat Tier 1 adversary vehicle and body armors; selection of propulsion and energetic materials and technology to validate novel energetic materials concepts to exploit controllable energy release for future gun/missile systems; scalable effects for mixed target defeat while simultaneously decreasing warhead mass; development of materials solutions for improvement of weight and volume efficiency, lethal effects and sustainability for the warfighter in the Army of today and beyond; and multiple pathways to enhance lethal effects by investigating synergistic effects of novel micro warheads using advanced materials. Funding in this PE is a continuation of work done in PEs 0602105A (Materials Technology), 0602618A (Ballistics Technology), and 0602624A (Weapons and Munitions Technology).

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*

Work in this PE complements PEs 0602147A (Long Range Precision Fires Technology), 0602150A (Air and Missile Defense Technology), 0602143A (Soldier Lethality Technology), 0602144A (Ground Technology), 0602145A (Next Generation Combat Vehicle Technology), and 0603116A (Lethality Advanced Technology).

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

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

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	0.000	26.961	30.215	-	30.215
Current President's Budget	0.000	69.961	42.425	-	42.425
Total Adjustments	0.000	43.000	12.210	-	12.210
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	43.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	12.210	-	12.210

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2019	FY 2020
Project: BS6: *Lethality Technology (CA)*		
Congressional Add: *Medium Range Railgun Weapon System*	-	20.000
Congressional Add: *Additive Manufacturing Research*	-	5.000
Congressional Add: *Mobile Environment Contaminant Sensors*	-	5.000
Congressional Add: *Hybrid Additive Manufacturing*	-	8.000
Congressional Add: *Next Generation Air-Breathing Propulsion Technology*	-	5.000
Congressional Add Subtotals for Project: BS6	-	43.000
Congressional Add Totals for all Projects	-	43.000

Change Summary Explanation

FY20 increase was due to $43.000 million of Congressional Add funding.

Exhibit R-2, **RDT&E Budget Item Justification:** PB 2021 Army	**Date:** February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*

FY21 increase due to realignment of PE 0602147A (Long Range Precision Fires Technology)/Project AG8 (Advanced Energetics Technology) to PE 0602141A (Lethality Technology)/Project AH9 (Advanced Warheads Technology).

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH5 / *Projectile and Multi-Function Warhead Technologies*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AH5: *Projectile and Multi-Function Warhead Technologies*	-	0.000	3.446	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.446

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602618A Ballistics Technology
* Project H80 Survivability and Lethality Technology

In FY21, this Project is being realigned to:
PE 0602143A Soldier Lethality Technology
* Project AY6 Soldier Squad Small Arms Armaments Technology
PE 0602145A Next Generation Combat Vehicle Technology
* Project BK5 Adv Direct In-Direct Armament Sys (ADIDAS) Tech

A. Mission Description and Budget Item Justification

This Project designs and validates novel lethal mechanism technologies to reduce energy or mass required to defeat emerging armor threats and provide multipurpose options for revolutionary capability to include defeat of advanced Tier 1 adversary vehicle and body armors.

This research is coordinated with PE 0602141A (Lethality Technology) / Project AH7 (Lethal and Scalable Effects Technologies), PE 0602143A (Soldier Lethality Technology / Project AY6 (Soldier Squad Small Arms Armaments Technology), and PE 0603462A (Next Generation Combat Vehicle Advanced Technology) / Project BF5 (Adv Lethality & Accuracy System for Med Cal Adv Tech) and builds upon weapon target interaction research in PE 0601102A Defense Research Sciences / Project AA7 (Mechanics and Ballistics).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Defeat of Adversary Vehicle Armors	-	2.219	-
Description: This effort designs, models and evaluates longer range, higher velocity munitions though reduction of parasitic mass required to launch and deliver lethality via new composite materials and architecture; Develops higher energy, more lethal cannon			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH5 / *Projectile and Multi-Function Warhead Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
(1.5X M256) through modification of blast field. This effort provides testing and modeling and simulation of Lightweight 50mm Armor Piercing round for advanced, direct-fire medium caliber weapons. ***FY 2020 Plans:*** Will develop projectiles that resist ricochet and maintain fragmentation lethality. Demonstrate robust penetrator concept versus threat Tier 1 armor. Demonstrate full scale tank gun muzzle blast mitigation to enable defeat of threat Tier 1 armor. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21, this effort is realigned to PE 0602145A (Next Generation Combat Vehicle) / Project BK5 (Adv Direct In-Direct Armament Sys (ADIDAS) Tech).			
Title: Defeat of Adversary Body Armor ***Description:*** This effort designs, models and evaluates defeat mechanisms for adversary body armor through time-resolved penetration mechanics and energy efficient munitions. This effort supports the development of small caliber lethal mechanisms for PE 0602143A (Soldier Lethality Technology) / Project AY6 (Soldier Squad Small Arms Armaments Technology). ***FY 2020 Plans:*** Will develop high fidelity computer models to predict the performance of novel penetrators versus body armors and metallic targets; Perform high spatial and temporal resolution radiographic and phase contrast imaging during ballistic impact of conventional and advanced penetrator systems to assist in computational model calibration, parameterization and validation; Develop and apply new diagnostic techniques to highly transient dynamic impact problems. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21, this effort is realigned to PE 0602143A (Soldier Lethality Technology) / Project AY6 (Soldier Squad Lethality Tech).	-	1.071	-
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.156	-
Accomplishments/Planned Programs Subtotals	-	3.446	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH5 / *Projectile and Multi-Function Warhead Technologies*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH6 / *Disruptive Energetics and Propulsion Technologies*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AH6: *Disruptive Energetics and Propulsion Technologies*	-	0.000	8.275	8.432	-	8.432	8.602	8.775	8.874	8.874	0.000	51.832

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602618A Ballistics Technology:
* Project H80 Survivability and Lethality Technology

A. Mission Description and Budget Item Justification

This Project investigates, models and evaluates energetic material and propulsion technologies to validate novel concepts such as maximizing total energy density and power delivered on target. This Project also optimizes propellant grains for increased range, and altering gun configurations to increase energy on target in order to exploit the controllable/scalable energy release required for improving effectiveness and reducing vulnerability of future gun/missile systems. This Project builds upon disruptive energetic materials discovery efforts to synthesize new materials with energy content from 50% to up to five times that of Research Department Explosive (RDX) in PE 0601102A (Defense Research Sciences) / Project AA7 (Mechanics and Ballistics). This Project also leverages the advanced additive manufacture efforts of PE 0602144A (Ground Technology) / Project BL1 (Materials and Manufacturing Research Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Synthesis, Formulation and Diagnostics of Energetic Materials	-	4.827	5.072
Description: This effort pursues novel approaches to synthesize and scale up disruptive and traditional energetic materials with increased performance as well as design new formulation avenues in order to discover new materials and formulations to extend range and increase effect on target. This effort also investigates and develops revolutionary ways to release energy and characterize energetic behavior at early time and small length scales for rapid determination of detonation and propellant performance parameters to enable a ?fail early, fail often? strategy. ***FY 2020 Plans:*** Will develop new materials and formulations with 50% better performance than current state of the art. Potential molecules for transition as melt cast / eutectics formulations are (go/no-go depending on passing safety, scale-up, and performance			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH6 / *Disruptive Energetics and Propulsion Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
parameters). Will utilize previous or currently under development micro-scale diagnostic techniques to characterize and evaluate traditional and disruptive energetic candidates for use as high performing rocket / gun propellants or explosive formulations. ***FY 2021 Plans:*** Will continue to develop new materials and formulations with 50% better performance than current state of the art; develop scale-up processes of molecules for transition as melt cast / eutectics formulations (go/no-go depending on passing safety, scale-up, and performance parameters); develop new energetic plasticizers and high-temperature materials; formulate new explosive and propellants using synthesized materials (both energetic and polymer); utilize previous or currently under development micro-scale diagnostic techniques to characterize and assess traditional and disruptive energetic candidates for use as high performing rocket / gun propellants or explosive formulations. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increase to support planned new material development activities.			
Title: Modeling and Simulation of Energetics and Munitions ***Description:*** This effort develops, codes and subsequently employs advanced models to predict multiscale response of energetic materials for both propellant and explosive purposes. Develops new simulation methods for understanding and design of advanced concepts and energetic formulations to rapidly iterate and optimize towards increased range and enhanced lethality ***FY 2020 Plans:*** Will incorporate 1) improved predictive software capability for gun interior ballistics design and 2) equation of state and reactivity from first principles into the warhead design continuum software suite. Simulation results will be transitioned to formulators and advanced concept designers. ***FY 2021 Plans:*** Will continue to investigate improved predictive capability for gun interior ballistics design into energetics and munitions software and equation of state and reactivity from first principles into the warhead design continuum software suite; will design simulation results with and transitioned to formulators and advanced concept designers. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increase to support additional simulations needed to mature models for predicted response of energetic materials.	-	1.627	1.787
Title: Advanced Weapon Concepts ***Description:*** This effort investigates new propellants and grain designs, burn rate/combustion modifier ingredients, as well as new gun and munition designs for extended range. ***FY 2020 Plans:***	-	1.445	1.573

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH6 / *Disruptive Energetics and Propulsion Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will develop and evaluate advanced additively manufactured propellant designs and geometries to produce higher muzzle energy, longer range gun launched munitions. Will evaluate novel nanocrystalline gun barrel coatings for increased temperature/pressure tolerance produced from Project AH8 (Lethality Materials and Processes Technologies) within this PE. ***FY 2021 Plans:*** Will continue to develop and assess advanced additively manufactured propellant designs and geometries to produce higher muzzle energy, longer range gun launched munitions; will develop new gun geometries to maximize muzzle velocity while decreasing system weight. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Nominal planned change of scope			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.376	-
Accomplishments/Planned Programs Subtotals	-	8.275	8.432

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH7 / *Lethal and Scalable Effects Technologies*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AH7: *Lethal and Scalable Effects Technologies*	-	0.000	1.869	1.057	-	1.057	1.954	1.328	1.540	1.540	0.000	9.288

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602618A Ballistics Technology:
* Project H80 Survivability and Lethality

A. Mission Description and Budget Item Justification

Work in this Project designs, fabricates and evaluates technology options for scaling warhead lethality and providing extreme efficiency for highly effective, simultaneous mixed/multi target defeat and collateral damage. This Project will also design and evaluate scalable structure defeat to mitigate collateral damage for disruptive urban Warfighting. This research is coordinated with Project AH5 (Projectile and Multi-Function Warhead Technologies) and Project AH6 (Disruptive Energetics and Propulsion Technologies) within this PE and builds upon disruptive energetic and ballistic sciences research in PE 06011102A Defense Research Sciences / Project AA7 Mechanics and Ballistics.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Munition Efficiency and Scalability	-	1.869	1.057
Description: This effort investigates, designs, models and evaluates technologies to produce blast-fragment warheads with tailored fragment geometries to optimize target defeat; Identifies and develops warhead impact patterns to optimize target defeat with reduced collateral damage; Designs, codes and evaluates technologies for the cost effective, preprogrammed delivery of multiple scalable warheads capable of simultaneously engaging multiple targets. This effort leverages guidance technologies from PE 0602147A (Long Range Precision Fires) / Project AH4 (Precision and Coop Weapons in a Denied Env Tech), and metal additive manufacturing from PE 0602144A (Ground Technology) / Project BL1 (Materials and Manufacturing Research Technology).			
FY 2020 Plans: Will develop warhead impact patterns to optimize target defeat with minimum energy, reduced number of warheads and minimum collateral damage; Will additively manufacture and evaluate tailored fragment geometries for optimal target defeat; Will build			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH7 / *Lethal and Scalable Effects Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
upon FY19 progress to evaluate methodologies for tailored warhead delivery. Demonstrate preprogrammed, predefined pattern delivery of three warheads. ***FY 2021 Plans:*** Will conduct experiments, simulations, and analytic analyses to determine spatial and temporal requirements to achieve synergistic effects; will continue to design high fidelity models to optimize munition for mixed target sets and improved models for weapons effects in urban environments; will perform vulnerability and lethality studies to select lethal mechanisms for modular munitions ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funds realigned to higher priority Army Science and Technology efforts.			
Accomplishments/Planned Programs Subtotals	-	1.869	1.057

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH8 / *Lethality Materials and Processes Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AH8: *Lethality Materials and Processes Technology*	-	0.000	3.954	4.046	-	4.046	4.109	4.026	4.071	4.112	0.000	24.318

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602105A Materials Technology:
* Project H84 Material

A. Mission Description and Budget Item Justification

Work in this Project designs, fabricates, and evaluates, innovative materials solutions aimed at achieving leap ahead increases in lethality and weapons effectiveness through improvements in weight and volume efficiency, lethal effects, and sustainability of military systems. This research is coordinated with Projects AH6 (Disruptive Energetics and Propulsion Technology) and Project AH7 (Lethal and Scalable Effects Technologies) within this PE, and PE 0602147A (Long Range Precision Fires Technology) / AH4 (Precision and Cooperative Weapons in a Denied Environment) and builds upon and ballistic sciences research in PE 0601102A (Defense Research Sciences) / Project AA7 (Mechanics and Ballistics).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Materials for Advanced Lethality	-	3.774	4.046
Description: This effort researches innovative materials aimed at achieving leap-ahead increases in lethality and weapons effectiveness through improvements in weight and volume efficiency, lethal effects, and sustainability of military systems that can only be achieved through advances in materials technology.			
FY 2020 Plans: Will develop three-dimensional woven carbon-carbon (C-C) composite preform and new resins, guided by modeling and simulation, to create low defect C-C composite structures for hypervelocity missile components; will develop 3-dimensional (3D) printable energetic polymers for gun and rocket propellant applications, along with computational capabilities to optimize burn rates and temperature profiles of printed propellant architectures and transition to Project AH6 (Disruptive Energetics and Propulsion Technologies); will create novel materials and processing methods to enable printing of integrated conductive and dielectric structures onto highly maneuverable flight bodies for PE 0602147A (Long Range Precision Fires Technology) / AH4			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH8 / *Lethality Materials and Processes Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
(Precision and Coop Weapons in a Denied Env Tech); will finalize optimal copper-tantalum alloy design and scale-up processing to enable performance demonstrations and for Project AH5 (Projectile and Multi-Function Warhead Technologies) within this PE. ***FY 2021 Plans:*** Will conduct performance testing on C-C composites to withstand the high temperature regimes of large caliber gun launch and flight while retaining structural integrity; conduct three-dimensional printing at 100 micron resolution optimized with energetic propellants to achieve designed progressive burn rates sufficient to increase projectile speeds and ranges in support of PE 0602147A (Long Range Precision Fires Technology). ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Nominal change of scope			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.180	-
Accomplishments/Planned Programs Subtotals	-	3.954	4.046

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH9 / *Advanced Warheads Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AH9: *Advanced Warheads Technology*	-	0.000	9.417	23.802	-	23.802	27.069	27.610	29.416	29.545	0.000	146.859

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602624A Weapons and Munitions Technology:
* Project H28 Warheads / Energetics Technology

A. Mission Description and Budget Item Justification

This Project explores multiple pathways to enhance lethal efforts for future warheads against emerging peer/near peer target sets. Investigates synergistic effects of novel micro warheads using advance materials. This Project investigates innovative energetic materials and novel processing techniques for the next generation of explosives and propulsion applications to enable an increase in range, lethality, and utility of munitions. It also directly supports Army Modernization Priorities through researching and developing energetic (propellant) technologies and processes for increased performance, expanded operation temperature bounds, and improved safety and environmental compliance of missile systems.

Work in this Project complements PE 0602147A (Long Range Precision Fires Technology) / AG6 (Energetic Materials and Advanced Processing Techno), PE 0603464A (Long Range Precision Fires Advanced Technology / AG7 (Energetic Materials and Adv Processing Adv Tech),PE 0602150A (Air and Missile Defense Technology), PE 0602148A (Future Vertical Lift Technology), and 0602145A (Next Generation Combat Vehicle Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Advanced Warheads	-	8.990	10.902
Description: This effort explores multiple pathways to enhance lethal effects for future warheads against emerging peer/near peer target sets; Investigates synergistic effects of novel micro warheads using advance materials.			
FY 2020 Plans: Will explore multiple pathways to enhance lethal effects and mission kills on a variety of anti-personnel and anti-materiel targets to ensure lethality overmatch in peer/near-peer engagements. Directional and adaptive warhead technologies will be designed using modeling, simulation and experimentation to reduce collateral damage, enhance soldier survivability and augment effect on target.			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH9 / *Advanced Warheads Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
The use of advanced materials and novel warhead designs, in conjunction with the development of novel initiation schemes, will be validated through experimentation to determine their efficacy in providing lethality overmatch and multi-domain capability. ***FY 2021 Plans:*** Will investigate reactive materials and advanced fragmentation technology to increase lethality by imparting additional energy and enhanced effects on target; will investigate novel structural materials and tunable warhead technologies that will provide additional lethality while enabling survivability in high-g gun environments. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increase due to additional exploration of lethal effects.			
Title: Advanced Energetics ***Description:*** This effort develops advanced energetic formulations and processing techniques to enable an increase in range, lethality, and effectiveness of munitions. ***FY 2021 Plans:*** Will develop nano-energetic component technologies for use in melt-cast formulations. Will develop polymer kinetics for amorphous energetics; investigate next-generation melt-cast and cast-cure ingredients for higher energy formulations. Will investigate reaction kinetics for ingredient synthesis. Investigate energetic materials to enable novel energy release mechanisms; design and develop processing parameters necessary to produce energetic materials for additive manufacturing; develop new techniques to accurately predict energetic materials performance in novel and unique geometries ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increase due to realignment from PE 0602147A Long Range Precision Fires Technology / Project AG8 Advanced Energetics Technology.	-	-	11.700
Title: Energetics (Propellants) ***Description:*** This effort investigates new and emerging energetic ingredients and processes for propellant formulations to enable enhanced performance and mission flexibility by extending the reach and effects of tactical and strategic missile systems. ***FY 2021 Plans:*** Will investigate current and future substances that provide higher delivered specific impulse density in rocket propellants; novel binders (both energetic and inert); advanced processing techniques to improve mass fraction; will investigate improved combustion properties to improve efficiency. ***FY 2020 to FY 2021 Increase/Decrease Statement:***	-	-	1.200

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AH9 / *Advanced Warheads Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Funding increase due to realignment from PE 0602141A Lethality Technology / Project AG8 Advanced Energetics Technology			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.427	-
Accomplishments/Planned Programs Subtotals	-	9.417	23.802

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AI1 / *Advanced Terrain Shaping Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AI1: *Advanced Terrain Shaping Technology*	-	0.000	0.000	5.088	-	5.088	4.090	3.848	2.112	0.000	0.000	15.138

Note

In Fiscal Year (FY) 2021 this Project is being realigned from:
Program Element (PE) 0602141A Lethality Technology
* Project AI2 Rapid Risk Analysis of Fires Technology
PE 0603116A Lethality Advanced Technology
* Project AI3 Rapid Risk Analysis of Fires Advanced Technology

A. Mission Description and Budget Item Justification

This Project designs and develops engineering tools and high-fidelity modeling and simulation capabilities for materials and structural response to predict high-velocity weapons performance to ensure effective lethality against structures and critical assets. Through dynamic impact experiments for a broad range of velocities against conventional and advanced structural materials, this project will develop engineering tools and technologies to rapidly evaluate and predict weapon performance.

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

Work in this Project is performed by the United States Engineer Research and Development Center (ERDC) in coordination with United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Advanced Terminal Weapons Effects Technology	-	-	5.088
Description: This effort develops and validates terminal weapons effects prediction capabilities for Long Range Precision Fires (LRPF) weapons against geomaterials, structures, and other critical assets. ***FY 2021 Plans:*** Will conduct laboratory and field experiments to develop and validate modeling and simulation capabilities for accurate prediction of terminal effects and lethality; will design and develop fast running engineering tools to support LRPF weapon design optimization and performance evaluation; and will design critical structural targets with advanced protective materials to validate weapon performance. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding realigned from other Projects to support terminal weapons effects analysis and predictive modeling research.			
Accomplishments/Planned Programs Subtotals	-	-	5.088

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** AI1 / *Advanced Terrain Shaping Technology*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602141A / *Lethality Technology*	**Project (Number/Name)** BS6 / *Lethality Technology (CA)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BS6: *Lethality Technology (CA)*	-	0.000	43.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	43.000

Note

Congressional Interest Item funding provided for Lethality Technology.

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Lethality Technology.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Medium Range Railgun Weapon System ***FY 2020 Plans:*** Medium Range Railgun Weapon System	-	20.000
Congressional Add: Additive Manufacturing Research ***FY 2020 Plans:*** Additive Manufacturing Research	-	5.000
Congressional Add: Mobile Environment Contaminant Sensors ***FY 2020 Plans:*** Mobile Environment Contaminant Sensors	-	5.000
Congressional Add: Hybrid Additive Manufacturing ***FY 2020 Plans:*** Hybrid Additive Manufacturing	-	8.000
Congressional Add: Next Generation Air-Breathing Propulsion Technology ***FY 2020 Plans:*** Next Generation Air-Breathing Propulsion Technology	-	5.000
Congressional Adds Subtotals	-	43.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	**Date:** February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602142A / *Army Applied Research*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	0.000	30.819	30.757	-	30.757	29.510	29.474	29.314	29.667	0.000	179.541
BS1: *Army Applied Research*	-	0.000	30.819	30.757	-	30.757	29.510	29.474	29.314	29.667	0.000	179.541

A. Mission Description and Budget Item Justification

The Army Applied Research budget line includes systematic application of knowledge toward the production of useful materials, devices and systems or methods including the design, development and improvement of science and technology for Army applications.

Efforts in this budget line include studies, investigations and non-system specific technology efforts leading to bread-board hardware or proof of principle analysis.

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	0.000	25.319	25.467	-	25.467
Current President's Budget	0.000	30.819	30.757	-	30.757
Total Adjustments	0.000	5.500	5.290	-	5.290
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	5.500			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	5.290	-	5.290

Change Summary Explanation

Increase in FY 2021 funding supports mission efforts.

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army												Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**	**FY 2022**	**FY 2023**	**FY 2024**	**FY 2025**	**Cost To Complete**	**Total Cost**
Total Program Element	-	0.000	145.900	125.435	-	125.435	130.599	129.536	127.716	126.940	0.000	786.126
AN1: *Narrowband SATCOM Technology*	-	0.000	4.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.000
AY6: *Soldier Squad Small Arms Armaments Technology*	-	0.000	18.345	13.122	-	13.122	12.404	15.901	15.131	15.132	0.000	90.035
AY8: *Small Arms Fire Control Technology*	-	0.000	0.000	1.898	-	1.898	4.224	2.120	0.000	0.000	0.000	8.242
AZ2: *Body Armor & Integrated Headborne Technology*	-	0.000	8.427	6.575	-	6.575	6.747	6.922	7.021	6.022	0.000	41.714
AZ5: *Soldier Protection Technology - Vulnerability*	-	0.000	8.104	12.248	-	12.248	12.659	14.149	14.317	14.318	0.000	75.795
AZ9: *Soldier Protection Advanced Tech - Detectability*	-	0.000	4.500	3.391	-	3.391	5.472	5.498	5.559	5.559	0.000	29.979
BB4: *Dismounted Soldier Survivability Materials*	-	0.000	4.946	3.093	-	3.093	3.863	3.955	4.013	4.013	0.000	23.883
BB5: *Physical Augmentation: Tech for Human Interactions*	-	0.000	1.500	1.499	-	1.499	1.499	1.499	1.516	1.531	0.000	9.044
BB7: *Exoskeleton: Technology for Man-Machine Interface*	-	0.000	1.600	1.599	-	1.599	1.631	0.000	0.000	0.000	0.000	4.830
BB9: *Human Performance Tech for Mobility & Lethality*	-	0.000	2.500	2.997	-	2.997	2.997	0.000	0.000	0.000	0.000	8.494
BC2: *Next Gen Mobility & Lethality Tech for Warfighters*	-	0.000	5.678	7.514	-	7.514	7.820	2.594	2.623	2.649	0.000	28.878
BC3: *Soldier Decision Making & Comms Performance Tech*	-	0.000	10.759	4.408	-	4.408	4.517	4.627	4.712	4.762	0.000	33.785
BC6: *Human Perf - Tech for Warfighter Enhancement*	-	0.000	2.676	3.023	-	3.023	3.392	1.418	1.376	1.390	0.000	13.275
BC7: *Training Technology (Other than STE)*	-	0.000	0.000	14.155	-	14.155	14.421	14.690	14.830	14.782	0.000	72.878

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army												Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*							
BD1: *Adv Soldier Sensors/ Displays Tech for Dismounts*	-	0.000	4.967	11.467	-	11.467	12.059	16.118	16.298	16.300	0.000	77.209
BD6: *Soldier Sys Interfaces/ Integration- Sensor Tech*	-	0.000	1.124	1.119	-	1.119	0.920	0.966	0.796	0.804	0.000	5.729
BD8: *Soldier & Sm Unit Tactical Energy Tech*	-	0.000	9.145	9.043	-	9.043	9.154	11.424	11.574	11.691	0.000	62.031
BE1: *Support Technology to Mission Command*	-	0.000	0.726	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.726
BE3: *Joint Service Combat Feeding Technology*	-	0.000	3.996	4.109	-	4.109	4.073	4.764	4.817	4.817	0.000	26.576
BE6: *Reactive/Resp Surfaces & Matls-Soldiers & Sys*	-	0.000	2.745	6.317	-	6.317	3.021	3.153	3.555	3.591	0.000	22.382
BE8: *Synthetic Training Environment (STE) Technology*	-	0.000	15.438	14.133	-	14.133	16.207	15.787	15.963	15.964	0.000	93.492
BP9: *Soldier Lethality Technologies (CA)*	-	0.000	30.626	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	30.626
BR9: *Personnel & Airdrop Safety Technology*	-	0.000	4.098	3.725	-	3.725	3.519	3.951	3.615	3.615	0.000	22.523

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is realigned with continuity of effort from the following PEs:
* 0602105A Materials Technology
* 0602308A Advanced Concepts and Simulation
* 0602618A Ballistics Technology
* 0602623A Joint Service Small Arms Program
* 0602624A Weapons and Munitions Technology
* 0602705A Electronics and Electronic Devices
* 0602709A Night Vision Technology
* 0602712A Countermine Systems
* 0602716A Human Factors Engineering Technology
* 0602786A Warfighter Technology

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*

A. Mission Description and Budget Item Justification

This PE conducts fundamental research on Soldier Lethality technologies to develop an integrated Soldier and Squad architecture of equipment and systems that improve Soldier and Small Combat Unit survivability, sustainability, mobility, combat effectiveness, and individual cognitive and physical readiness. To address the challenges of integrating multiple technologies and sub-systems, research conducted in this PE, significant Science and Technology applied research investments in all areas of Soldier Lethality, focus on how to improve the effectiveness of the technologies a Soldier utilizes and apply systems-level practices to mitigate constraints from size and weight of the equipment. Research areas encompass individual and crew-served weapon designs and technologies as well as applied research in lightweight and transparent armor materials to mitigate effects from blast and ballistic threats, counter explosive hazard detection, counter-sensor capabilities, and signature management of weapons, equipment, personnel and high value targets. This PE investigates, develops and designs materials, technologies, methodologies and system models required to experiment and optimize Soldier lethality and survivability through investments in mobility, human-agent teaming, and improved situational awareness interfaces and display technologies as well as to provide Soldier-borne power and energy materials and components that support multiple Soldier-borne systems. This PE also investigates Warfighter training technologies and develops the underpinning technologies to establish architecture standards and interfaces necessary for creating realistic synthetic environments to create a single, interconnected synthetic training system to enable Army units and leaders to conduct realistic multi-echelon / multi-domain combined arms maneuver and mission command training, increasing proficiency through repetition. Human Factors Engineering projects conduct applied research to design weapon systems standards, guidelines, handbooks, and Soldier training curriculum and tools.

Results of these efforts are transitioned within the Army Futures Command, the Program Executive Offices, Army Training and Doctrine Command (TRADOC), Army Medical Command (MEDCOM), Human Systems Integration (HSI) Directorate (Army G1), and the Army Test and Evaluation Command (ATEC).

Work in this PE complements PE 0603118A (Soldier Lethality Advanced Technology).

All FY21 adjustments align program financial structure to Army Modernization Priorities in support of the National Defense Strategy.

Work in this PE is performed by the United States Army Futures Command (AFC).

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	**Date:** February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*

B. Program Change Summary ($ in Millions)	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**
Previous President's Budget	0.000	115.274	126.345	-	126.345
Current President's Budget	0.000	145.900	125.435	-	125.435
Total Adjustments	0.000	30.626	-0.910	-	-0.910
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	30.626			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	-0.910	-	-0.910

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2019**	**FY 2020**
Project: BP9: *Soldier Lethality Technologies (CA)*		
Congressional Add: *Medical simulation and training*	-	3.626
Congressional Add: *Active and passive camouflage concealment and deception*	-	3.000
Congressional Add: *Human systems integration*	-	10.000
Congressional Add: *Expeditionary mobile base camp technology*	-	2.000
Congressional Add: *SOCOM communications capability*	-	2.500
Congressional Add: *Soldier Lethality Technologies Program Increase*	-	5.000
Congressional Add: *Harnessing Emerging Soldier Lethality Technology Research*	-	4.500
Congressional Add Subtotals for Project: BP9	-	30.626
Congressional Add Totals for all Projects	-	30.626

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AN1 / *Narrowband SATCOM Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AN1: *Narrowband SATCOM Technology*	-	0.000	4.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.000

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602782A Command, Control, Communications Technology:
* Project H92 Communications Technology

In FY21 this Project is being realigned to:
PE 0602146A Network C3I Technology
* Project BZ6 Narrowband SATCOM Technology
PE 0603463A (Network C3I Advanced Technology)
* Project AN2 Narrowband SATCOM Advanced Technology

A. Mission Description and Budget Item Justification

This Project designs and develops technologies to enable gateway communications across disparate Narrowband Satellite Communications (SATCOM) networks, enabling resiliency in contested environments. The Narrowband SATCOM network is the largest tactical network operated by the Army to provide situational understanding across all echelons. This Project investigates technologies and protocols to enable risk mitigation solution sets and awareness through adaptive learning capabilities. FY20 realignments are due to financial restructuring in support of Army Modernization Priorities.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) / Project AN2 (Narrowband SATCOM Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Narrowband Satellite Communication Technology	-	3.819	-
Description: This research effort designs and develops technologies to enable gateway communications across disparate Narrowband SATCOM networks, enabling resiliency in contested environments. The Narrowband SATCOM network is the largest tactical network operated by the Army to provide situational understanding across all echelons. This project investigates technologies and protocols to enable risk mitigation solution sets and awareness through adaptive learning capabilities.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AN1 / *Narrowband SATCOM Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Design and develop an agile, network-defined architecture to enable core network transport capabilities that can interface with, and control traditional and non-traditional Narrowband networks; and develop and mature functional components required to integrate assured, resilient network transport operations in a mobile, congested and contested environment. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This effort is realigned to support the Network CFT in PE 0602146A (Network C3I Technology).			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.181	-
Accomplishments/Planned Programs Subtotals	-	4.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AY6 / *Soldier Squad Small Arms Armaments Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AY6: *Soldier Squad Small Arms Armaments Technology*	-	0.000	18.345	13.122	-	13.122	12.404	15.901	15.131	15.132	0.000	90.035

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
PE 0602623A Joint Service Small Arms Program
* Project H21 Joint Service Small Arms Program (JSSAP)
PE 0602618A Ballistics Technology
* Project H80 Soldier Protection Technology - Vulnerability
PE 0602716A Human Factors Engineering Technology
* Project H70 Human Factors Engineering System Development

A. Mission Description and Budget Item Justification

This Project investigates individual and crew-served weapon designs and technologies that enhance the fighting capabilities and survivability of the dismounted Warfighter in support of all of the Services. In addition, it conceives and advances weapon concepts based on innovative ballistic and advanced incapacitation technologies that will enhance the defeat of hard and soft infantry targets at extended ranges based upon the Joint Service Small Arms Technology Development Strategy (JSATDS). The Project will continue to support technology needs from the all Services to include the Next Generation Family of Weapons. In addition, this Project will develop the technology/weapons concepts that will upgrade medium and heavy support weapons at echelons. Finally, this Project will perform research directed toward non-kinetic modalities to incapacitate combatants.

Work in this Project supports key Army needs and leverages the technical research of several PEs to include PE 0601102A (Defense Science Research) / Project AA7 (Mechanics and Ballistics), PE 0603118A (Soldier Lethality Advanced Technology), and PE 0602141A (Lethality Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Soldier/Squad Lethality Technology	-	2.072	4.103
Description: This effort conceives and investigates advanced weapons concepts based on innovative ballistic technologies that will enhance the defeat of hard and soft infantry targets at extended ranges to ensure overmatch in Soldier and Squad lethality. This effort will also perform research directed toward non-ballistic modalities to incapacitate combatants.			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AY6 / *Soldier Squad Small Arms Armaments Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2020 Plans: Identify novel lethal mechanisms for future weapons concepts and technical approaches to for increased lethality at reduced energy for behind armor/barrier threats; identify and characterize technology concepts to enable a 50% reduction in dispersion for complex design projectiles; identify and demonstrate mechanisms for incapacitation through synthetic motor control in animal models. ***FY 2021 Plans:*** Will continue to identify novel lethal mechanisms for future weapons concepts and technical approaches for increased lethality at reduced energy for behind armor/barrier threats; utilize state of the art instrumentation to further characterize technology concepts to enable a reduction in dispersion for complex projectiles; determine benefits in capability for novel weapons systems for increased performance of heavy small caliber weapons as well as precision systems; and assess biological effects and incapacitation potential of advanced high powered microwave and acoustic directed energy technologies in small and large animal models. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding realigned from PE 0602141A (Lethality Technology) / AH5 (Projectile and Multi-Function Warhead Technologies) for additional research into weapon systems mechanisms.			
Title: Human-Agent Interactions for Intelligent Squad Weapons ***Description:*** This effort investigates enhanced target acquisition, situational awareness, and shooting performance through Soldier-centered integration of intelligent technologies and distributed information in augmented squad weapons. Enhances operational performance of individuals and teams of Soldiers through novel weapon and human-agent interaction technologies. ***FY 2020 Plans:*** develop techniques to improve the Automated Target Recognition (ATR) training algorithms based on Soldier feedback to mitigate the severe size, weight and power (SWAP) constraints inherent in Soldier-carried weapons. ***FY 2021 Plans:*** Will develop and document knowledge products, including data analysis documentation and guidelines for Soldier/Advanced Target Recognition (ATR) interaction methods, contributing to a framework for bidirectional ATR display and interaction techniques, aimed at maximizing Soldier-intelligent fire control teamed target acquisition performance and situational awareness within the usable field of view. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	3.408	3.713
Title: Next Generation Carbine Technology (NGCT)	-	1.333	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AY6 / *Soldier Squad Small Arms Armaments Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort develops next generation squad weapon systems and ammunition by providing tech insertions to augment capabilities and mitigate risks. Mature small arms weapon system components and validate them through experimentation in support of the Joint Warfighter?s capability needs. Mature weapon system technology readiness levels and validate confidence of functionality in advanced operating scenarios. ***FY 2020 Plans:*** Validate recoil and shock pressures and determine metrics to compensate for increased muzzle velocity; conduct experiments on Next Generation Carbine Technology systems to ascertain probability of incapacitation effects. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Effort completes in FY20.			
Title: Next Generation Family of Ammo (NGFoA) ***Description:*** This effort designs and develops a family of ammunition for automatic rifles and carbine weapons with the objective of decreasing weight, increasing lethality and hit performance over current fielded systems; develops capabilities to defeat threat targets at extended ranges. ***FY 2020 Plans:*** Conduct propulsion research and experiments to determine pressure, time and velocity of weapon systems; develop the Next Generation Family of Ammunition Combat Tracer; mature component technologies for projectile design, soft/hard target and launch optimization, and modeling and simulation support for validation of capabilities. ***FY 2021 Plans:*** Will finalize maturation of component technologies for the next generation of small arms training rounds, training tracer projectiles, and ammunition training aides; conduct experiments with mature tracer component technologies to validate tracer design performance characteristics. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding decreased to support PE 06030118A (Soldier Lethality Adv Technology) / AY5 (Soldier Squad Small Arms Armaments Advanced Tech) to support demonstration of next generation ammunition technologies.	-	6.334	1.677
Title: Small Arms Enabling Technologies ***Description:*** This effort designs and develops small arms weapon systems, enablers, and ammunition technologies that will maintain decisive lethal overmatch capabilities to the Joint Warfighter. This effort matures small arms weapon system designs through experimentation in support of Joint Warfighter's capability needs.	-	4.365	3.629

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AY6 / *Soldier Squad Small Arms Armaments Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2020 Plans: Investigate the advanced weapon operating technologies (recoil, accuracy, signature, materials, controllability, maintainability, materials, and coatings); conduct experiments on Small Arms Remote Weapon Stations to include component technology in the areas of advanced target recognition, next generation weapon system and lightweight stabilized mounts to enable an increase in the probability of hit on a target. ***FY 2021 Plans:*** Will investigate emerging small arms technologies to develop remote powered armament systems, advanced target recognition and aim augmentation, alternate barrel materials and coatings, signature reduction technologies, etc.; continue investigation of small arms remote armament component technologies for increasing the overall probability of hit. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.833	-
Accomplishments/Planned Programs Subtotals	-	18.345	13.122

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AY8 / *Small Arms Fire Control Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AY8: *Small Arms Fire Control Technology*	-	0.000	0.000	1.898	-	1.898	4.224	2.120	0.000	0.000	0.000	8.242

Note

In Fiscal Year 2021 (FY21), this Project is realigned from:
Program Element (PE) 0602143A Soldier Lethality Technology
* Project BB4 Dismounted Soldier Survivability Materials
PE 0603118A Soldier Lethality Advanced Technology:
* Project AZ8 Soldier Squad Small Arms Armaments Adv Tech
* Project BB3 Dismounted Soldier Survivability Equip/Tech Integ
* Project BB6 Physical Augmentation: Adv Tech for Field Demo

A. Mission Description and Budget Item Justification

This Project designs and develops enabling technology for advanced small arms fire control in order to achieve lethality overmatch by supporting target prioritization, enhancing processing of information from multiple sources, and investigating aim assistance tools which remove Soldier aim error. This Project specifically supports the Army Science and Technology Soldier Lethality modernization priority.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas, the Army Modernization Strategy, and the Soldier Lethality Cross Functional Team (CFT) efforts. All FY21 adjustments align program financial structure to Army Modernization Priorities in support of the National Defense Strategy.

This Project complements work done in PE 0603118A (Soldier Lethality Advanced Technology) / AY7 (Small Arms Fire Control Advanced Technology).

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Adv. Fire Control Tech	-	-	1.898
Description: This Project investigates software and hardware mechanisms to enable enhanced kill chain processes on small arms platforms. This includes investigating artificial intelligence and neural network hardware, conducting experiments on both Commercial and Government Off-The-Shelf (COTS and GOTS) artificial intelligence and machine learning algorithms, and validating Soldier accuracy performance models. It also includes investigation of lightweight optical components and determines viability of weight reduction and balancing approaches.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AY8 / *Small Arms Fire Control Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will refine technical requirements based on capability needs; investigate existing artificial intelligence and machine learning algorithms on COTS & GOTS; determine implementation and validation approaches as well as research of human-system integration and pairing; and mature components of polymer lens and housing technologies, and three-dimensional printing solutions. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increased from PE 0603118A (Soldier Lethality Advanced Technology) / BB6 (Physical Augmentation: Adv Tech for Field Demo), AZ8 (Soldier Squad Small Arms Armaments Adv Tech), BB3 (Dismounted Soldier Survivability Equip/Tech Integ), and PE 0602143A (Soldier Lethality Technology) / BB4 (Dismounted Soldier Survivability Materials) to address fire control acceleration in support of Army Modernization Priorities in this area.			
Accomplishments/Planned Programs Subtotals	-	-	1.898

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AZ2 / *Body Armor & Integrated Headborne Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AZ2: *Body Armor & Integrated Headborne Technology*	-	0.000	8.427	6.575	-	6.575	6.747	6.922	7.021	6.022	0.000	41.714

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602786A Warfighter Technology
* Project H98 Clothing & Equipment Technology

A. Mission Description and Budget Item Justification

This Project investigates and develops materials for Soldier-borne protective equipment, such as body armor and combat helmets, to increase protection from ballistic, blast, and blunt impact threats. This Project also investigates and executes systematic studies to mature and develop materials, devices, systems and methods that enable the identification of protective solutions against ballistic, blast and directed energy threats. Included are investigations of emerging technologies, novel materials, and test methods and integration of personnel armor, combat helmets, hearing protection, eyewear, and other personal protective equipment items.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Body Armor & Integrated Headborne Technology	-	8.044	6.575
Description: This research effort supports the investigation of novel materials, component designs, and material modeling to design and develop technologies that protect Soldiers against ballistic, blast, and directed energy threats. This effort utilizes a cross-disciplinary, human-focused approach to develop technologies which optimize tradeoffs in ballistic and blast protective component design. This effort addresses the Army challenge of easing overburdened Soldiers in small units and aligns to Soldier protection modernization priorities.			
FY 2020 Plans: Advance research toward material and technology development in support of an integrated single lens substrate for use in a Soldier vision protection systems that improves variable light transmission lenses with laser flash and dazzle protection, investigate high hardness coatings, as well as experiments on alternative technologies to mitigate lens deterioration and extend operational life; will mature the performance envelope of a repeatable laboratory test method that is capable of evaluating the performance of head-borne equipment in a simulated near free-field blast overpressure environment; develop modeling and analysis tools to quantify the terminal ballistic loading of small arms threats to the combat helmet and head to assist the scaling			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AZ2 / *Body Armor & Integrated Headborne Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
of head injury criteria to inform future helmet performance and injury biomechanics; systematically investigate material composite pre-stress processing methods to increase ballistic material mechanical properties during composite laminate processing to enhance ballistic performance. ***FY 2021 Plans:*** Will mature components of an integrated single lens substrate for use in Soldier vision protection system that includes anti-fog, variable light transmission, and lenses with laser flash and dazzle protection capabilities; conduct analytical and laboratory studies to physically validate the performance of high hardness and anti-fog coatings to protect and extend the operational life of various Soldier-borne display technologies; validate the operating performance capability of the advanced blast simulator and its correlation to free field blast overpressure conditions from artillery and antipersonnel threats as a means to systematically study headborne equipment in a controlled blast environment; validate material composite pre-stress processing methods and investigate its use with multiple material substrates as a means to enhance the ballistic performance of multiple end-items. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding in this effort was realigned to PE 0603118A (Soldier Lethality Advanced Technology) / AY9 (Body Armor & Integrated Headborne Adv Tech) to support the acceleration of next generation headborne protection system demonstration.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.383	-
Accomplishments/Planned Programs Subtotals	-	8.427	6.575

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AZ5 / *Soldier Protection Technology - Vulnerability*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AZ5: *Soldier Protection Technology - Vulnerability*	-	0.000	8.104	12.248	-	12.248	12.659	14.149	14.317	14.318	0.000	75.795

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602105A Materials Technology
* Project H84 Materials
PE 0602618A Ballistics Technology
* Project H80 Survivability and Lethality Technology

A. Mission Description and Budget Item Justification

This Project investigates and develops materials, methods, and models that enable design and integration of emerging material technologies into lightweight, flexible and modular Soldier equipment to protect against the range of existing and emerging threats for head, torso, and extremity protection. Specific research thrusts include the development of materials and mechanisms to enhance ballistic protection; computational models and associated experiments to provide a fundamental understanding of material properties and failure mechanisms, as well as correlation to ballistic/blast/blunt impact performance of Soldier personal protective equipment (PPE) and improved fibers, composite, and ceramic materials. Specific technologies include experimental helmets that reduce impact and blast loading to the head, Soldier torso protection systems to increase protection from ballistic and blunt impacts, and novel fibers and fabrics that provide additional survivability mechanisms.

Work in this Project supports key Army needs and is fully coordinated with several PEs to include PE 0602143A (Soldier Lethality Technology) and 0603118A (Soldier Lethality Advanced Technology); and leverages the technical research of several PEs to include PE 0601102A (Defense Research Sciences) / Project AA7 (Mechanics and Ballistics) and 0602144A (Ground Technology) / Project BL1 (Materials and Manufacturing Research Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Soldier Protection Technologies	-	4.009	4.211
Description: This effort develops integrated lightweight, flexible, and modular protection equipment that is tailored to support the 'Soldier as a system' approach for defeat of emerging threats. Research areas encompass high fidelity ballistic impact injury models for hard and soft tissues, novel ceramic architectures to include graded and hierarchically structured ceramics, and novel fiber solutions for backing materials to deliver Soldier protection systems to meet emerging ballistic and signature management			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AZ5 / *Soldier Protection Technology - Vulnerability*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
threats. This effort supports small caliber lethal mechanisms research in PE 0602143A (Soldier Lethality Technology) / Project AY6 (Soldier Squad Small Arms Armaments Technology). ***FY 2020 Plans:*** Perform computational/experimental analysis of disruption mechanisms against legacy bullet technologies; simulate helmet/pad/head interaction for various loading scenarios; investigate soft tissue and hard tissue injury mechanisms; explore new concepts in limb protection from blast events; develop armor model to explore behind armor blunt trauma metrics. ***FY 2021 Plans:*** Will design and develop armor mechanisms to protect dismounted Soldiers from emerging ballistic threats through experimental and computational analysis; increase head protection through determination of advanced mitigation techniques; investigate thoracic soft tissue and hard tissue injury mechanisms; continue to explore new concepts in limb protection from blast events; validate armor model for behind armor blunt trauma metrics. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Soldier-Borne Composite Materials ***Description:*** Utilizing understanding of fibers, fabrics, and composite materials, conduct applied research of emerging lightweight materials and structures to enable affordable designs for head, torso, and extremity protection systems. Provide quantitative scientific basis for modeling and simulation that result in materials that utilize new schemes to enhance Warfighter survivability. This effort supports Soldier Protection Technologies bullet. ***FY 2020 Plans:*** Demonstrate efficient and complete synthesis of novel fibers and films for soft body armor and head protection solutions; demonstrate computational framework of multi-physics-based helmet process models that simulate the thermoforming of compound curvature geometries providing process-induced microstructure and process histories that serve as critical input into ballistic impact simulations. ***FY 2021 Plans:*** Will explore the processing and layout of novel fibers and films as a composite for potential soft body/torso armor and head protection (helmets); and investigate computational methodology processes and the resulting structure-performance relationships of composites for helmets. ***FY 2020 to FY 2021 Increase/Decrease Statement:***	-	2.556	2.310

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AZ5 / *Soldier Protection Technology - Vulnerability*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Funding change reflects planned lifecycle of this effort.			
Title: Soldier-Borne Advanced Protection Materials ***Description:*** Utilizing understanding of protection materials such as armor ceramics and associated failure mechanisms, conduct applied research of emerging armor materials to enable affordable design of lightweight ballistic protective systems for the future Soldier. Provide quantitative scientific basis for modeling and simulation that result in materials that utilize new lethal mechanisms/ protection schemes for the individual Warfighter. This effort supports Soldier Protection Technologies bullet and small caliber lethal mechanisms research in PE 0602143A (Soldier Lethality Technology) / Project AY6 (Soldier Squad Small Arms Armaments Technology), ***FY 2020 Plans:*** Develop processing pathways to fabricate armor ceramic with novel multiscale heterogeneity and characterize ballistic performance; create experimental technique to characterize ceramic blends and ceramic failure to include the fragment size distribution and the subsequent flow of damaged material under tri-axial states of stress. ***FY 2021 Plans:*** Will explore novel ceramics and ceramic structures for ballistic applications; develop processing pathways for multiscale architectures and assess their ballistic performance; research experimental techniques to assess failure mechanisms for multiscale architectures under ballistically-relevant states of stress. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	1.171	2.730
Title: Multifunctional Soldier Materials - Soldier Augmentation ***Description:*** This effort researches novel multifunctional Soldier protection materials and associated processing science aimed at enabling critical Army applications in survivability via Soldier augmentation technologies. Research efforts include: multifunctional fibers, films, and coatings; adaptive and responsive materials for passive biomechanical assistance; materials for sensing body forces and kinematics; materials for high power and high speed actuation; actuator fibers and textiles; functionally graded materials; and color-changing materials. ***FY 2021 Plans:*** Will explore the development of new materials and structures, both passive and active that can be integrated with the human body to modify human biomechanics, and /or change color on demand; determine metamaterial structures that can be reconfigured rapidly and with spatial complexity to re-direct load paths or enhance energy absorption in real time. ***FY 2020 to FY 2021 Increase/Decrease Statement:***	-	-	2.997

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AZ5 / *Soldier Protection Technology - Vulnerability*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.368	-
Accomplishments/Planned Programs Subtotals	-	8.104	12.248

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AZ9 / *Soldier Protection Advanced Tech - Detectability*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AZ9: *Soldier Protection Advanced Tech - Detectability*	-	0.000	4.500	3.391	-	3.391	5.472	5.498	5.559	5.559	0.000	29.979

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602786A Warfighter Technology
* Project H98 Clothing and Equipm Tech

A. Mission Description and Budget Item Justification

This Project investigates and designs novel materials, technologies, techniques and applications increasing the capabilities of camouflage and concealment against known and emerging sensor threats. The results of this project enable effective deception capabilities, combinations of physical and electronic signature decoy components, and determination of analytical processes for modeling signature management technologies during multi-domain operations. These technologies will provide subsystems and concepts that shall decrease the probability of detection and targeting by peer and near-peer adversaries, enabling freedom of movement of semi-independent and dispersed formations and increased protection of high-valued assets. Components designed under this project will transition to Advanced Technology Development efforts in Soldier Lethality protection/survivability Projects to provide disruptive Camouflage, Concealment and Deception technologies to the Operational Army to support expeditionary maneuver in the Multi-Domain Battle Environment and retain windows of advantage.

Work in this Project supports key Army needs and leverages/complements the technical research of several PEs to include PE 0601102A (Defense Research Sciences), PE 0602143A (Soldier Lethality Technology) / Project BB4 (Dismounted Soldier Survivability Materials), Project AZ5 (Soldier Protection Technology - Vulnerability), Project BE1 (Support Technology to Mission Command), PE 0603118A (Soldier Lethality Advanced Technology) / Project AZ8, (Soldier - Small Unit Detectability Adv Technology), and PE 0602712A (Countermine Systems) / Project H35 (Camouflage and Counter-Recon Tech).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Camouflage, Concealment and Decoys Technologies for Soldier and High-Value Assets	-	4.296	3.391
Description: This effort investigates and designs materials, processes, and concepts for innovative camouflage, concealment and deception technologies for Soldier and High-Value assets to defeat advanced current and emerging adversary Intelligence, Surveillance and Reconnaissance (ISR) threats including multispectral, hyperspectral and Light Detection and Ranging (LiDAR) sensors, and to reduce the probability of detection in multi-domain operations. Investigates analytical processes to model material and system performance and predict probability of detection in the multi-domain operational environment, assisting in closing the			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AZ9 / *Soldier Protection Advanced Tech - Detectability*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
capability gap between current camouflage, concealment, and deception technologies and defeating enemy sensorial capabilities in future operating environments. ***FY 2020 Plans:*** Validate preliminary performance effectiveness of camouflage technologies under development; determine design metrics to discern performance of candidate camouflage system solutions in support of future hyperspectral and LiDAR sensor defeat; investigate analytical models for predicting performance; determine the effectiveness of candidate decoy systems in deceiving peer and near-peer adversaries; mature versatile optical film technology for standoff-based signature concealment in visual and near infrared spectral ranges to camouflage to conceal Soldiers and small ground assets; conduct experiments to assess dismounted Soldier vulnerability against enemy ground surveillance radar; investigate flexible Soldier worn materials to reduce Soldier radar cross section; explore active color changing materials for potential Soldier clothing and individual equipment; investigate near infrared, identification of friend versus foe capability for the individual Soldier. ***FY 2021 Plans:*** Will leverage performance effectiveness of camouflage materiel technologies to mature components of most promising solutions; determine design metrics that will be relevant for defeating known emerging sensor threats; leverage data showing vulnerability against ground surveillance radar for experimenting with flexible Soldier worn materials to reduce Soldier radar cross section; investigate technologies to alert Soldiers if detected by ground surveillance radar; design and mature components of active color changing materials for future integration into Soldier clothing and individual equipment; research alternative active and passive identification of friend versus foe capabilities for the individual Soldier to provide tailorable mission-dependent capability; validate performance effectiveness of new camouflage technologies against continuously emerging and changing threats based on previous results; evaluate camouflage system solutions in support of new/emerging hyperspectral and LiDAR sensor defeat; interrogate candidate deception solutions; continue to investigate color and optical property changing materials for high value asset concealment, utilizing varying environments. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding in this effort was realigned to PE 0602146A (Network C3I Technology) / AQ9 (Expeditionary Data to Decisions Technology).			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:***	-	0.204	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** AZ9 / *Soldier Protection Advanced Tech - Detectability*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	-	4.500	3.391

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BB4 / *Dismounted Soldier Survivability Materials*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BB4: *Dismounted Soldier Survivability Materials*	-	0.000	4.946	3.093	-	3.093	3.863	3.955	4.013	4.013	0.000	23.883

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602786A Warfighter Technology
* Project H98 Clothing and Equipment Technologies

A. Mission Description and Budget Item Justification

This Project investigates fibers, textiles, components, and materials focused on enhancing Soldier survivability from combat threats (flame and thermal, blast and ballistic, multispectral sensor, and laser threats) and environmental threats (e.g., cold, heat, wet, vector, antimicrobial, etc.) to increase operational effectiveness while decreasing the Soldier's physical and cognitive burden. The results from this Project will transition knowledge, materials, subcomponents and methods to Advanced Technology Development efforts in support of enhancing Soldier Lethality by providing protective material solutions focused on the aspects of dismounted movement and maneuver operations of the Army. This Project develops and applies validation methods that enable systematic studies of human systems integration principles and practices to protective equipment materials and designs to advance the understanding of trade-offs between protection, lethality, and mobility.

Work in this Project supports key Army needs and leverages/complements the technical research of several PEs to include PE 0601102A (Defense Research Sciences), PE 0602143A (Soldier Lethality Technology) / Project AZ5 (Soldier Protection Technology - Vulnerability), Project BB4 (Dismounted Soldier Survivability Materials), and PE 0603118A Soldier Lethality Advanced Technology / Project BB3 (Dismounted Soldier Survivability Equip/Tech Integ).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Dismounted Soldier Survivability Materials	-	4.722	3.093
Description: This effort investigates materials, devices and methods that aid in the design and development of multifunctional materials for Soldier protective clothing and individual equipment. This effort conducts research to investigate and identify multi-functional material properties at the micron and sub-micron level to mitigate Soldiers susceptibility and vulnerability to operational threat, i.e., flame, thermal, environmental, and multispectral sensors. Efforts also investigate and develop devices and systems that enable extended dismounted mission duration by reducing the demand for water resupply and enabling Squad organic water filtration systems			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BB4 / *Dismounted Soldier Survivability Materials*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2020 Plans: Develop and conduct experiments on novel textile architectures and weaves to provide protection against microwave frequency threats through reflection and scattering of directed energy; determine the efficacy of novel sensors that systematically measure heat flux during system and component flame resistance testing to quantify body region burn injuries; and explore materials and processes that enable individual Soldiers to desalinate contaminated water for hydration during emergency and extended semi-independent operations. ***FY 2021 Plans:*** Will conduct experiments on novel multi-component fiber architectures and fabric treatments to incorporate functionalities for improved durability over the life of the garment, providing more effective protection against operational threats for a longer period; design fibers and fabrics that can transmit power supporting integration of wearable electronics for situational awareness and decreased load; continue to investigate and validate materials and processes that enable individual Soldiers to desalinate contaminated water such that proper hydration levels can be maintained from any indigenous water source. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding in this effort decreased to support higher priority modernization areas of PE 0603118A (Soldier Lethality Advanced Technology) / BB3 (Dismounted Soldier Survivability Equip/Tech Integ).			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.224	-
Accomplishments/Planned Programs Subtotals	-	4.946	3.093

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army												Date: February 2020
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*				Project (Number/Name) BB5 / *Physical Augmentation: Tech for Human Interactions*			
COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BB5: *Physical Augmentation: Tech for Human Interactions*	-	0.000	1.500	1.499	-	1.499	1.499	1.499	1.516	1.531	0.000	9.044

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602786A Warfighter Technology
* Project H98 Clothing and Equipm Tech

A. Mission Description and Budget Item Justification

This Project advances the understanding of human augmentation and interaction for enhanced operational performance with a focus on adaptation, training, human variability, metrics/methodologies for assessment, and task quantification. Research encompasses conducting applied research to develop metrics, measures, tools, and techniques to quantify and understand the relationships that enable maximum effectiveness of integrated Soldier-augmentation technologies. The resulting data are the basis for physical augmentation systems and equipment design standards, guidelines, and intelligent agent requirements to improve equipment operation and Soldier-system synergy. Application of this research will yield reduced workload, reduced Soldier training requirements, enhanced Soldier lethality/survivability, user acceptance, and allow Soldiers to achieve maximum performance. Major efforts explore novel techniques for Soldier assessment, characterization of individual variability effects on performance, development of evidence based design guidance for the application of augmentation technologies, exploration of the relationship of exoskeleton and physical assist device adaptation and baseline Soldier parameters such as gait, neuromuscular motor control and proprioception. This Project will also explore novel training paradigms for reduced Soldier-augmentation technology adaptation times to address current and future warrior performance issues. Individual efforts exploit wearable sensor technologies, translate surrogate task performance to operational outcomes, develop approaches to distinguish tasks and individual state and intent of movement, establish database of human movement variability to inform intelligent system design, and identify high impact applications of augmentation.

Work in this Project supports key Army needs and leverages the technical research of several PEs to include PE 0602143A (Soldier Lethality Technology) / Project BC2 (Next Gen Mobility & Lethality Tech for Warfighters), Project BB9 (Human Performance Tech for Mobility & Lethality), Project BC6 (Human Perf - Tech for Warfighter Enhancement), and Project BB7 (Exoskeleton: Technology for Man-Machine Interface); and supports PE 0603118A (Soldier Lethality Advanced Technology) / Project BC1 (Human Performance AdvTech for Mobility & Lethality), Project BB6 (Physical Augmentation: Adv Tech for Field Demo), and Project BB8 (Soldier Centric Advanced Technology). Additionally, work in this Project complements and is fully coordinated with the Medical Research and Development Command under the Military Operational Medicine Research Program within PE 0602787A (Medical Technology) / Project 869 (Warfighter Health Prot & Perf Stnds), and the Veteran Administration's exoskeleton research area. This Project also complements and is fully coordinated with work performed across Army, Navy, and Air Force under the Reliance 21 Human Systems Community of Interest: Protection, Sustainment, and Warfighter Performance and with our international partners through The Technical Cooperation Program / Human Resources and Performance Group / Panel JP1 (TTCP HUM JP1).

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

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BB5 / *Physical Augmentation: Tech for Human Interactions*

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Training Adaptation and Movement Science ***Description:*** This effort investigates the science behind movement for physical augmentation to maximize mobility capacity and training adaptation to decrease learning curve with physical augmentation systems (e.g. physical assist devices, exoskeletons). This work will enable the Army to make informed decisions on the ultimate effectiveness of human augmentation technologies before significant resources are expended. ***FY 2020 Plans:*** Conduct experiments to understand how Soldiers adapt to using physical augmentation/exoskeleton type devices; investigate factors that predict slow vs fast adaptation to design training interventions so physical augmentation systems are utilized optimally for the greatest performance benefit; investigate bio-signals that predict change in human movement to develop design criteria for augmentation systems that are capable of anticipating changes in movement states (e.g. walk to sprint) and adjusting in real time. ***FY 2021 Plans:*** Will mature design criteria and develop training interventions to optimize physical augmentation systems for the greatest performance benefit; validate design criteria for smart controls of augmentation systems that are capable of anticipating changes in movement states (e.g. walk to sprint) and adjusting in real time based on previously categorized Soldier movement characteristics; conduct experiments that manipulate control parameters of augmentation systems to determine optimal control settings for various tasks and individuals. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	1.432	1.499
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.068	-
Accomplishments/Planned Programs Subtotals	-	1.500	1.499

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BB5 / *Physical Augmentation: Tech for Human Interactions*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BB7 / *Exoskeleton: Technology for Man-Machine Interface*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BB7: *Exoskeleton: Technology for Man-Machine Interface*	-	0.000	1.600	1.599	-	1.599	1.631	0.000	0.000	0.000	0.000	4.830

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602716A Human Factors Engineering Technology
* Project H70 Human Fact Eng Sys Dev

A. Mission Description and Budget Item Justification

This Project conducts applied research on metrics, measures, tools, and techniques to understand the relationships which enable maximum effectiveness of integrated Soldier-augmentation technologies. The resulting data are the basis for physical augmentation systems and equipment design standards, guidelines, and intelligent agent requirements to improve equipment operation and Soldier-system synergy. Application of this research will yield reduced workload, reduced Soldier training requirements, enhanced Soldier lethality/survivability, user acceptance, and allows the Soldier and systems to jointly achieve maximum performance. Major efforts explore novel techniques for Soldier assessment, characterization of individual variability effects on performance, and development of evidence based design guidance for the application of augmentation technologies to address current and future warrior performance issues. Individual efforts exploit wearable sensor technologies, translate surrogate task performance to operational outcomes, develop approaches to distinguish tasks and individual state, establish database of human movement variability to inform intelligent system design, and identify high impact applications of augmentation.

Results of these efforts supports key Army needs and leverages the technical research of PEs 0602143A (Soldier Lethality Technology) and 0603118A (Soldier Lethality Advanced Technology). Additionally, this work complements and supports the Medical Research and Development Command under PE 0602787A (Medical Technology), Army Training and Doctrine Command (TRADOC), Human Systems Integration (HSI) Directorate (Army G1), and the Army Test and Evaluation Command (ATEC).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Exoskeleton	-	1.527	1.599
Description: This effort will accelerate Soldier lifting and mobility capabilities through applied research on exoskeleton systems with improved safety and reduced training requirements.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BB7 / *Exoskeleton: Technology for Man-Machine Interface*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Refine surrogate tasks and associated performance metrics for dismounted operations scenario and begin developing consolidated assessment approach; investigate relationships between human movement variability and performance outcomes for quasi-operational dismounted Soldier tasks; investigate trade-offs between physical task requirements and performance outcomes, and develop approaches to classify and discriminate between tasks to support optimization of intelligent system design and control parameters. ***FY 2021 Plans:*** Will conduct experiments with integrated operational scenario and performance metrics for assessment of dismounted Soldier performance; expand models of human movement variability and performance outcomes to inform development of adaptive system designs and control approaches. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.073	-
Accomplishments/Planned Programs Subtotals	-	1.600	1.599

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BB9 / *Human Performance Tech for Mobility & Lethality*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BB9: *Human Performance Tech for Mobility & Lethality*	-	0.000	2.500	2.997	-	2.997	2.997	0.000	0.000	0.000	0.000	8.494

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602786A Warfighter Technology
* Project H98 Clothing and Equipm Tech

A. Mission Description and Budget Item Justification

This Project investigates human performance based information portrayal system design parameters that integrate mobility & lethality considerations (such as cognitive workload, target discrimination and engagement, and fatigue) into training/education tools, mission command platforms, and technologies that help Soldiers more rapidly and efficiently acquire complex skills and make decisions quickly from training through mission planning and execution.

Work in this Project directly supports integration of design guidance for multiple PE/Projects including PE 0603118A (Soldier Lethality Advanced Technology) / Project BD7 (Soldier Sys Interfaces/ Integration-Sensor Adv Tech), Project AY9 (Body Armor & Integrated Headborne Advanced Tech), and Project BC9 (Adv Soldier Sensors/ Displays AdvTech for Dismounts).

Work in this Project complements and is fully coordinated with the Medical Research and Development Command under the Military Operational Medicine Research Program as well as Defense Medical Research and Development Program under Military Operational Medicine (JPC-5) to include Projects in PE 0602787A (Medical Technology). This Project also complements and is fully coordinated with work performed across Army, Navy, and Air Force under the Reliance 21 Human Systems Community of Interest: Systems Interfaces & Cognitive Processes. Work in this Project supports key Army needs and leverages the technical research efforts at the Simulation and Training Technology Center to support synthetic training environments.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas, the Army Modernization Strategy and the Soldier Lethality Cross Functional Team (CFT), as well as the Office of the Secretary of Defense's Close Combat Lethality Task Force.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Human Interaction for Situational Understanding	-	2.386	2.997

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BB9 / *Human Performance Tech for Mobility & Lethality*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort investigates, designs, and develops design guidance for information portrayal systems and sub-systems in augmented/virtual reality that enable Soldiers to make better, faster decisions for close combat operations at the small unit level. This effort also conducts experiments to populate performance models that have application across materiel and non-materiel solutions. ***FY 2020 Plans:*** Investigate impact of multimodal cuing (e.g. audio, visual, haptic) in augmented and virtual reality on decision making with navigation and target engagement in simulated operational environments; measure Soldiers response time, cognitive burden, behavioral, physiological and neurophysiological responses to inform what and how information should be portrayed to a Soldier in order for it to be meaningful and actionable. ***FY 2021 Plans:*** Will investigate the impact of virtual reality and augmented reality design parameters (e.g. graphical level of detail, uncertainty, degraded network conditions, focal depth) on decision-making, situational awareness, and navigation; continue to investigate Soldiers? response time, cognitive burden, and behavioral measures of performance to inform what and how information should be portrayed to a Soldier in order for it to be meaningful and actionable. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increase to support increased testing of human situational understanding.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.114	-
Accomplishments/Planned Programs Subtotals	-	2.500	2.997

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BB9 / *Human Performance Tech for Mobility & Lethality*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army												Date: February 2020
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*				Project (Number/Name) BC2 / *Next Gen Mobility & Lethality Tech for Warfighters*			
COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BC2: *Next Gen Mobility & Lethality Tech for Warfighters*	-	0.000	5.678	7.514	-	7.514	7.820	2.594	2.623	2.649	0.000	28.878

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602786A Warfighter Technology
* Project H98 Clothing and Equipm Tech

A. Mission Description and Budget Item Justification

This Project investigates the means to monitor, assess and predict Soldier and squad shoot and move performance to provide design guidance for individual and mission specific equipment (e.g. individual protection, small arms, load carriage, etc.). Research conducted focuses on translating mission tasks to measures of human performance. These measures of human performance will inform predictive algorithms and human based modeling and simulation that enable Soldier performance trade space analysis for acquisition, training, and operations. These data and algorithms will allow us to determine the impact of new capabilities on Soldier and Squad performance and effectiveness.This Project supports the Measuring and Advancing Soldier Tactical Readiness and Effectiveness (MASTR-E) joint Science and Technology program supported by the Office of the Secretary of Defense Close Combat Lethality Task Force.

Work in this Project supports key Army needs and leverages the technical research of several PE/Projects to include PE 0602143A (Soldier Lethality Technology) / Project BB9 (Human Performance Technology for Mobility & Lethality), and Project BC6 (Human Perf - Tech for Warfighter Enhancement). This Project supports multiple Projects within PE 0603118A (Soldier Lethality Advanced Technology) including Project BB8 (Soldier Centric Advanced Technology), Project BC1 (Human Performance AdvTech for Mobility & Lethality), Project AY9 (Body Armor & Integrated Headborne Advanced Tech), Project AY5 (Soldier Squad Small Arms Armaments Advanced Technology), Project BD7 (Soldier Sys Interfaces/Integration-Sensor AdvTech), and Project BB6 (Physical Augmentation: Adv Tech for Field Demo).

Work in this Project complements and is fully coordinated with the Medical Research and Development Command under the Military Operational Medicine Research Program as well as Defense Medical Research and Development Program under Military Operational Medicine (JPC-5) to include Projects in PE 0602787A (Medical Technology). This Project also complements and is fully coordinated with work performed across Army, Navy, and Air Force under the Reliance 21 Human Systems Community of Interest: Protection, Sustainment, and Warfighter Performance.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas, the Army Modernization Strategy, and the Soldier Lethality Cross Functional Team (CFT), as well as the Office of the Secretary of Defense Close Combat Lethality Task Force.

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

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BC2 / *Next Gen Mobility & Lethality Tech for Warfighters*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Human Interaction for Mobility & Lethality ***Description:*** This effort investigates and develops human performance based design guidance for protection and weapon systems and sub systems to improve the mobility and lethality of individuals and small units. The applied research translates traditional means for measuring and understanding human performance to the means to conduct assessment for Warfighter and small unit readiness and/or new capabilities. ***FY 2020 Plans:*** Investigate physical and cognitive tolerances and fatigue on task performance with head borne systems with varying weight distribution properties (e.g. moment of inertia, center of gravity, etc.) to inform protective equipment designs; conduct experiments to populate movement & maneuver performance models that integrate with Nett Warrior and other programmed situational awareness systems; investigate, validate, and mature wearable sensor components that are surrogates for tactical tasks of shoot and move in order to provide the means for Soldier and Squad assessment for both training and test & evaluation purposes. ***FY 2021 Plans:*** Will identify, validate, and mature components of innovative wearable sensors and algorithms for monitoring and assessment of situational awareness, cognitive state, and decision-making during critical Soldier tasks to provide the means for Soldier and Squad assessment for both training and test & evaluation purposes; identify predictive measures for Soldier shoot, move, communicate, navigate, and decide tasks during conditions of physical and cognitive stress in future operating scenarios; determine quantitative data and algorithms to populate commander decision aids, a predictive squad performance model, and the Synthetic Training Environment (STE). ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding realigned from PE 0602143A (Soldier Lethality Technology) / BC3 (Soldier Decision Making & Comms Performance Tech).	-	5.421	7.514
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.257	-
Accomplishments/Planned Programs Subtotals	-	5.678	7.514

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BC2 / *Next Gen Mobility & Lethality Tech for Warfighters*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BC3 / *Soldier Decision Making & Comms Performance Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BC3: *Soldier Decision Making & Comms Performance Tech*	-	0.000	10.759	4.408	-	4.408	4.517	4.627	4.712	4.762	0.000	33.785

Note

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

A. Mission Description and Budget Item Justification

This Project conducts applied research to create analytical and empirical capabilities to characterize, model, and forecast human behavior related to cyber electromagnetic events through experimentation and field data collection. The result is increased mission effectiveness that enables strong mission command, intelligence operations, and cyber defenses, which lead to high information sharing, situational awareness, and collaboration. Major efforts focus on applied research to understand the conduct of effective cyber electromagnetic operations in that knowledge is required to create and effectively deploy cyber work systems that optimize human-machine interactions and account for operator and adversary behavior to achieve maximum effects. This Project also investigates technologies to quantify, predict, and enhance Squad-level shared Soldiers' situational awareness (SA) and understanding (SU) across volatile, uncertain, complex, and ambitious operating environments leading to demonstrated increases in mission effectiveness. The result of this effort will be systems that use real-time opportunistic measures of Soldier SA to adapt autonomous assets (routes, surveillance targets, etc.) based on dynamic needs of the Soldier/Squad due to changing mission environment. In addition, this Project will develop novel technologies and approaches to represent uncertain and dynamically changing information in a manner that is effective and quickly understood with reduced Soldier/Squad burden and minimal training requirements.

Results of these efforts are provided to Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) Program Managers, Human Systems Integration (HSI) Directorate (Army G1), and the Army Test and Evaluation Command (ATEC).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Soldier Performance in Sociotechnical Environments	-	10.270	2.960
Description: This research provides human cyber operations assessment and advanced human decision-support capabilities to deploy cyber work systems that optimize human-machine interactions and account for operator and adversary behavior. Without			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BC3 / *Soldier Decision Making & Comms Performance Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
these capabilities, future cyber work systems will be too complex and burdensome for operator use and training resulting in critical bottlenecks as operators have to ?catch-up? with the speed of cyber activity. This research also supports technologies for Squad-level SA assessment (information visualization) that provide command-level decision support with communication and intervention capabilities. Research focuses on algorithms for the quantification and visualization of collective uncertainty at the squad level for mission command decision making. This effort also supports the monitoring and assessing of Soldier tactical readiness and effectiveness through technologies and approaches for opportunistic human sensing. ***FY 2020 Plans:*** Complete work on the mission monitoring and team workflow modeling capabilities effort; develop knowledge engineering (ontologies) and inferencing techniques to enable intelligent systems to draw conclusions about the state of the world and make recommendations for decision making; develop and document knowledge products capturing best-practices for the Cyber Mission Force in response to previously developed cyber-attacks and scenario events; initiate a decision-support technology research effort; create a decision aid to enable individuals and teams to respond more effectively to the cognitive challenges of networked operations and cyber domain by optimizing human-machine interactions; develop initial prototype development by integrating workflow and mission monitoring prototype with data sources; and apply tools in a representative mission environment. ***FY 2021 Plans:*** Will develop and document knowledge products capturing best-practices and frameworks for the creation and exploitation of a physiological time-series database to enable Soldier performance prediction; conduct experiments with advanced machine learning algorithms on physiological time-series data to quantify situational awareness and predict performance of the dismounted Soldier/Squad. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding partially realigned to support the Algorithms for Sensing Soldier in Mission Context and within this Project and PE 0602143A (Soldier Lethality Technology) / BC7 (Training Technology (Other than STE)).			
Title: Algorithms for Sensing Soldier in Mission Context ***Description:*** This effort investigates enhanced decision making under conditions of uncertain, complex, time sensitive, and dynamically changing information to optimize human-artificial intelligence (AI) shared situational understanding. Enhances operational performance of individuals and teams of Soldiers through novel visualization technologies that represent complex time-sensitive information in uncertain dynamic environments. ***FY 2021 Plans:***	-	-	1.448

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BC3 / *Soldier Decision Making & Comms Performance Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will develop techniques for customized and intuitive visualizations to translate disparate and uncertain sources of complex, dynamic information into actionable knowledge for improved mission critical decision making. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding partially realigned from the Soldier Performance in Sociotechnical Environments effort in this Project to enable the capability to enhance Soldier decision making by presenting critical data to the right Soldier at the right moment in the mission.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.489	-
Accomplishments/Planned Programs Subtotals	-	10.759	4.408

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army												Date: February 2020
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*				Project (Number/Name) BC6 / *Human Perf - Tech for Warfighter Enhancement*			
COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BC6: *Human Perf - Tech for Warfighter Enhancement*	-	0.000	2.676	3.023	-	3.023	3.392	1.418	1.376	1.390	0.000	13.275

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602786A Warfighter Technology
* Project H98 Clothing and Equipm Tech

A. Mission Description and Budget Item Justification

This Project investigates and develops mechanisms for safely and effectively optimizing and enhancing Warfighter ability to shoot, move, communicate, and decide. These mechanisms have the potential to exploit the Soldier and Squad as the capability platform beyond materiel solutions provided to the individual and small unit. This project also conducts experiments to populate human performance models that enable tradespace analysis for portions of doctrine, organization, training, materiel, leadership and education, personnel and facilities (DOTMLPF) analysis. This Project supports the Measuring and Advancing Soldier Tactical Readiness and Effectiveness (MASTR-E) joint Science and Technology program supported by the Office of the Secretary of Defense Close Combat Lethality Task Force.

This Project is also fully coordinated and complementary with the following Projects within PE 0602143A (Soldier Lethality Technology) / Projects BC2 (Next Gen Mobility & Lethality Tech for Warfighters), BB9 (Human Performance Tech for Mobility & Lethality), and BE3 (Joint Service Combat Feeding Technology). It directly supports the following projects within PE 0603118A (Soldier Lethality Advanced Technology) / Projects BC1 (Human Performance AdvTech for Mobility & Lethality), BB8 (Soldier Centric Advanced Technology), BD7 (Soldier Sys Interfaces/Integration-Sensor AdvTech)), and BE2 (Joint Service Combat Feeding Advanced Technology). It also has potential to inform material solutions within PE 0603118A (Soldier Lethality Advanced Technology) for the Soldier/Small unit.

Work in this Project complements and is fully coordinated with the Medical Research and Development Command under the Military Operational Medicine Research Program as well as Defense Medical Research and Development Program under Military Operational Medicine (JPC-5) to include Projects in PE 0602787A (Medical Technology). This Project also complements and is fully coordinated with work performed across Army, Navy, and Air Force under the Reliance 21 Human Systems Community of Interest: Protection, Sustainment, and Warfighter Performance. Work in this Project complements and is fully coordinated with research at the US Army Combat Capabilities Development Command Army Research Laboratory (ARL).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas, the Army Modernization Strategy, and the Soldier Lethality Cross Functional Team (CFT), as well as the Office of the Secretary of Defense Close Combat Lethality Task Force.

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

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BC6 / *Human Perf - Tech for Warfighter Enhancement*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Human Performance Technology for Warfighter Enhancement ***Description:*** This effort investigates mechanisms for exploiting human physiology to develop safe and effective interventions that create smarter, faster, more lethal Close Combat Warfighters. This work will result in a Soldier's ability to shoot, move, communicate, and decide faster than an adversary. Findings from these experiments will leverage existing systems and platforms to get the greatest human performance return in training and operations. ***FY 2020 Plans:*** Conduct neurostimulation experiments to determine efficacy for tactically relevant improvements in skill acquisition and Warfighting tasks; conduct experiments with a benchtop gut microbiome model to identify ration components that use the gut/brain connection to enhance and inform leap ahead gains in Soldier performance. ***FY 2021 Plans:*** Will conduct experiments to investigate the trade space for whom, when, and how neurostimulation is effective for improving tactically relevant skill acquisition and performance; compare and validate available neurostimulation systems for administration and efficacy for performance enhancement; validate the individualized Soldier benchtop gut microbiome model to determine inter and intra personnel variations for enabling higher precision recommendations for nutritional interventions that enhance Soldier performance via the gut/brain connection. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	2.554	3.023
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.122	-
Accomplishments/Planned Programs Subtotals	-	2.676	3.023

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BC6 / *Human Perf - Tech for Warfighter Enhancement*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army												Date: February 2020
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*				Project (Number/Name) BC7 / *Training Technology (Other than STE)*			
COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BC7: *Training Technology (Other than STE)*	-	0.000	0.000	14.155	-	14.155	14.421	14.690	14.830	14.782	0.000	72.878

Note

In Fiscal Year 2021 (FY21) this Project is realigned from:
Program Element 0602143A Soldier Lethality Technology
* Project BC3 Soldier Decision Making & Comms Performance Tech
* Project BE8 Synthetic Training Environment (STE) Technology
* Project BE9 STE Advanced Technology

A. Mission Description and Budget Item Justification

This Project investigates novel medical training simulations that address all levels of care through improvements in haptic feedback and automated performance assessments in support of Army medical Individual Critical Task Lists (ICTLs). This Project designs and develops early proof-of concept training systems to support non-traditional medical areas, such as dental training simulations. This Project conducts research in immersive virtual, mixed, and augmented reality environments that stimulate human senses (e.g. sight, sound, and touch) and also conducts experiments to understand how users interface with the technology in order to improve the realism of simulation environments and therefore create enhanced immersion and more effective training systems. Research is also conducted to support the modernization of the current Live Training Environment (LTE) to allow fair fight engagements across all training environments and training devices.

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

Work in this Project is performed by the United States Army Futures Command (AFC) and at the Institute for Creative Technologies (ICT) University Affiliated Research Center (UARC) at the University of Southern California.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Medical Training Technology	-	-	3.695
Description: Included in this effort will be the development of new medical training simulations to train medical personnel across all levels of care. Improvements in haptic capabilities will ensure hyper bio-fidelity for all levels of care. Automated measures of student performance will support Army medical Individual Critical Task Lists (ICTLs). Research areas will also include more realistic tissue properties supporting part-task trainers and modular patient simulator systems. Initial exploration of Army ICTLs will result in early proof-of-concept development of proof-of concept training systems to support non-traditional medical areas, such as dental training simulations.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BC7 / *Training Technology (Other than STE)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will develop haptics capabilities supporting augmented, mixed, and virtual reality by extending sense of hyper bio-fidelity and integrating emerging research into automated objective performance measures supporting Individual Critical Task Lists (ICTLs); develop proof-of-concept training systems to close capability gaps between current simulation technologies and ICTL requirements; validate usability studies and training effectiveness evaluations to gauge value of initial proof-of-concept development efforts; investigate updates to military medical training protocols (e.g., new emphasis on prolonged field care); develop research plans to include proof-of-concept development, usability studies, technology, and training effectiveness evaluations. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding partially realigned to PE 0603118A (Soldier Lethality Advanced Technology) / BE9 (STE Advanced Technology) to support development of immersive visualization technologies for training.			
Title: Warfighting M/S Concepts and Design (ICT) ***Description:*** This Project designs and develops photorealistic synthetic environments, multi-sensory interfaces, artificially intelligent agents, and human performance assessment technologies to create virtual, augmented, and mixed reality simulation environments for training. This Project uses advanced modeling, simulation, and leadership development techniques to leverage the emerging immersive technologies of industry and the research and development community to advance the Army's capabilities. ***FY 2021 Plans:*** Will conduct research on immersive, virtual, mixed, and augmented reality environments that incorporate senses such as sight, sound, and touch; will develop tools, techniques and technologies to understand how users interface with technology to improve perceptions of immersion in simulated environments to create enhanced realism and more effective training systems. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding partially realigned to support PE 0602143A (Soldier Lethality Technology) / BE8 (STE Technology) to accelerate live training technology.	-	-	1.270
Title: Cyberspace Electromagnetic Activities (CEMA) Effects Modeling and Simulation ***Description:*** This effort investigates and develops capabilities to more accurately model and simulate Cyberspace Electromagnetic Activities (CEMA) necessary to support training events for Corps and below. ***FY 2021 Plans:***	-	-	1.460

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BC7 / *Training Technology (Other than STE)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will mature cloud-based network simulation components to support collective Army cyber training events; determine standard data representations to tag information on simulated networks sufficient for training Information Warfare techniques relevant to the conduct of Multi-Domain Operations (MDO); investigate collective training measurement methods for CEMA training assessments. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding was partially realigned from PE 0602143A (Soldier Lethality Technology) / BC3 (Soldier Decision Making & Comms Performance Tech).			
Title: Innovative Synthetic Training Technology ***Description:*** This effort investigates and designs methods of applying Artificial Intelligence (AI) into the STE to simulate a fully immersive environment in large urban settings with a population of adaptable, noncombatant virtual human agents for increasing the realism and complexity of training scenarios. In addition, it develops tools, techniques and technologies for improving the immersion of human senses within simulation environments with the goal of creating enhanced realism within the simulated environment. ***FY 2021 Plans:*** Will investigate neural networks and reinforcement learning techniques to simulate a ?fabric of Life? or fully immersive environment in a large urban setting with the population of adaptable, noncombatant virtual human agents to increase the realism and complexity of training scenarios; design and develop photorealistic synthetic environments, multi-sensory interfaces, artificially intelligent agents, and human performance assessment technologies to create virtual, augmented, and mixed reality simulation environments for training; investigate and design techniques and methods for integrating different sensory cues into virtual environments that result in enhanced training and leader development; and validate the design of virtual humans that embody natural language, gesture, gaze, and language understanding to simulate conversational speech within virtual humans. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding realigned from PE 0602143A (Soldier Lethality Technology) / BE8 (Synthetic Training Environment Technology).	-	-	5.509
Title: STE Live Training ***Description:*** This effort investigates technology to enhance the fidelity of live training systems and investigates future live training capabilities for conducting force-on-force, combined arms exercises to enhance readiness at Army home stations and Combat Training Centers. ***FY 2021 Plans:*** Will investigate eBullet capability to simulate tactical engagements with realism equivalent (or near) to Infantry weapon systems; investigate capability to simulate combat vehicle ballistic fly-out of munitions to a precise point of impact on target and accurately	-	-	2.221

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BC7 / *Training Technology (Other than STE)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
adjudicate weapon effects based on lethality/vulnerability models; investigate capability to simulate friendly and enemy combat vehicle vulnerability/lethality for battle damage assessment. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Accomplishments/Planned Programs Subtotals	-	-	14.155

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army												Date: February 2020
Appropriation/Budget Activity 2040 / 2					**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*				**Project (Number/Name)** BD1 / *Adv Soldier Sensors/Displays Tech for Dismounts*			
COST ($ in Millions)	**Prior Years**	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**	**FY 2022**	**FY 2023**	**FY 2024**	**FY 2025**	**Cost To Complete**	**Total Cost**
BD1: *Adv Soldier Sensors/ Displays Tech for Dismounts*	-	0.000	4.967	11.467	-	11.467	12.059	16.118	16.298	16.300	0.000	77.209

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602709A Night Vision Technology
* Project H95 Night Vision And Electro-Optic Technology
PE 0602712A Countermine Systems
* Project H24 Countermine Tech

A. Mission Description and Budget Item Justification

This Project designs and develops low power, next generation modular sensor and display components for detection and identification of both threats and friendlies in all environments. Work in this Project supports the Army Science and Technology Soldier Lethality, Next Generation Combat Vehicle, and Future Vertical Lift modernization priorities as well as the Soldier Lethality Cross Functional Team (CFT) effort.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2019**	**FY 2020**	**FY 2021**
Title: Advanced Soldier Sensors/Displays Technology for Dismounts	-	4.741	11.467
Description: This effort models, simulates, investigates, designs, and develops novel low power, modular electro-optic / infrared (EO/IR) and explosive hazard (EH) technologies, displays, augmented reality approaches and aided/automatic target detection and recognition algorithms that enable improved Soldier maneuver and lethality through greater information fidelity and automated algorithms to increase Soldier probability of recognition/identification and tracking of all threats. This effort is coordinated with PE 0603118A (Soldier Lethality Advanced Technology), PE 0603462A (Next Generation Combat Vehicle Advanced Technology), PE 0603463A (Network C3I Advanced Technology), PE 0603465A (Future Vertical Lift Advanced Technology), and PE 0602145A (Next Generation Combat Vehicle Technology).			
FY 2020 Plans: Develop methods to model and simulate EO/IR system performance for computer-aided prototyping design models and augmented reality applications; model emerging active and passive EO/IR technologies, applications, and threats (e.g. hostile fire			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BD1 / *Adv Soldier Sensors/Displays Tech for Dismounts*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
and unmanned aerial systems) to support sensor system designs and combinations; investigate target acquisition performance measures to address EO/IR signature countermeasures; and validate performance of novel augmented and mixed reality software in a variety of environments. ***FY 2021 Plans:*** Will validate computer-aided prototyping design models and augmented reality (AR) applications; develop synthetic image generation techniques to enable optimized designs of advanced electro-optic / infrared (EO/IR) sensors and algorithms; mature components of virtual prototyping capabilities to support validation of sensor performance against various threats; model performance of advanced low-light sensors in multiple, simulated battlefield conditions; investigate designs for backside illuminated silicon (BSI) complementary metal-oxide-semiconductor (CMOS) to validate approaches for improved quantum efficiency (QE) in near-IR for advanced low light level imaging; develop low power, high performance application specific integrated chips (ASIC) to reduce the size, weight, power, and cost of solid state low light level sensors; develop readout integrated circuits (ROICs) with pixel bins that provide high resolution, high definition imagery in darkest conditions. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Increase in funding from PE 0603118A (Soldier Lethality Advanced Technology) / BC9 (Adv Soldier Sensors/Displays AdvTech for Dismounts) to support acceleration of advanced low light sensors.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.226	-
Accomplishments/Planned Programs Subtotals	-	4.967	11.467

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BD6 / *Soldier Sys Interfaces/Integration-Sensor Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BD6: *Soldier Sys Interfaces/ Integration- Sensor Tech*	-	0.000	1.124	1.119	-	1.119	0.920	0.966	0.796	0.804	0.000	5.729

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602786A Warfighter Technology
* Project H98 Clothing & Equipm Tech

A. Mission Description and Budget Item Justification

This Project investigates, designs, and validates advanced technologies and algorithms for enhancing dismounted Soldier deployed robotics and autonomous systems used to improve the Small Unit's situational awareness, survivability, and lethality. Technologies to be investigated may include: algorithms for dismounted robotic systems to enable autonomous navigation, automated object recognition, persistent surveillance, launch and recovery from vehicles, networked lethality, manned-unmanned teaming, and collaborative behaviors; and advanced user interfaces to optimize human-robotic interaction during dismounted operations. These advanced technologies will enable Squad and Platoon level autonomous reconnaissance using robotic systems to minimize the operator's dedicated control of the systems and reduce their cognitive burden, thus allowing Soldiers to be more lethal and survivable.

Work in this Project supports key Army needs and leverages the technical research of several PEs to include PE 0603118A (Soldier Lethality Advanced Technology) / Project BD7 (Soldier Sys Interfaces/Integration-Sensor AdvTech) and Project BC9 (Adv Soldier Sensors/Displays AdvTech for Dismounts).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Soldier System Interfaces & Integration (Sensor Technology)	-	1.073	1.119
Description: This effort will investigate, design, and validate advanced dismounted Soldier robotic and autonomous systems technologies to enable autonomous navigation, manned-unmanned teaming, and networked reconnaissance to improve Soldier lethality, situational awareness, and survivability during tactical operations.			
FY 2020 Plans: Investigate and develop algorithms for dismounted Small Unit level Small Unmanned Aerial Systems (SUAS) to enable autonomous operations; investigate and design soldier-robotic user interfaces to minimize soldier dedicated control of robotic assets; investigate and develop modular robotics architectures to allow for a common platform to conduct validation of algorithms			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BD6 / *Soldier Sys Interfaces/Integration-Sensor Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
and enable integration of third party software and hardware components; and validate emerging technologies in controlled laboratory and simulated environments to assess functionality, reduce risk, and improve system design. ***FY 2021 Plans:*** Will investigate, design, and develop autonomous navigation algorithms, such as obstacle avoidance algorithms for fast flights and operations during night, to enhance the movement and maneuver of dismounted Small Unmanned Aerial Systems (UAS); investigate, design, and develop autonomous search and sensing algorithms to enable resource constrained Small UAS to perceive, detect, identify, and recognize objects in the environment; investigate, design, and develop mission and path planning algorithms and associated user interfaces for autonomous Small UAS; investigate, design, and develop algorithms to enable precision landing, recharging, and launch capabilities for Small UAS to enable extended operations; validate functionality of algorithms on open architecture Small UAS platforms in laboratory and simulated environment to reduce risk and improve system design. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.051	-
Accomplishments/Planned Programs Subtotals	-	1.124	1.119

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BD8 / *Soldier & Sm Unit Tactical Energy Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BD8: *Soldier & Sm Unit Tactical Energy Tech*	-	0.000	9.145	9.043	-	9.043	9.154	11.424	11.574	11.691	0.000	62.031

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602705A Electronics and Electronic Devices
* Project H11 Tactical and Component Power Technology
* Project H94 Elec & electronic Dev

A. Mission Description and Budget Item Justification

This Project conducts applied research and development on materials and component level power and energy technologies in the areas of energy storage, power generation, alternative energy, and intelligent power distribution and thermal management designs that support Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) and Soldier power needs to include next generation squad weapons and advanced optical devices and sensors. Enables future Soldier lethality and mobility for longer mission durations at lighter weights to provide enhanced lethality and tactical overmatch of adversaries, and to reduce the burden on the Soldier.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Tactical Power for Soldier Lethality	-	3.692	3.695
Description: This effort investigates, designs, and develops innovative materials and component level power generation and energy storage technologies that support next generation weapons, sensors, radios, and human augmentation devices enabling Soldiers and Small Units to maximize probability of target hits, improve collective situational awareness, ensure multiple communication streams, and assist with tactical tasks in order to decrease Soldier load and power burden, and increase power capabilities by providing more energy to prolong mission run-time.			
FY 2020 Plans: Conduct lab-based experiments on advanced cathode materials and pairings to assess its ability to increase the runtime of Soldier borne devices in small, lightweight, flexible form factors; optimize Silicon Anode materials for both primary and rechargeable configurations to enable greater energy densities from 300-500 WH/Kg for Soldier and Small Units that require more Power & Energy, with longer runtimes, in distributed operations, with limited resupply; investigate and develop small, power generation			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BD8 / *Soldier & Sm Unit Tactical Energy Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
devices that are powered by logistically available fuels to enable integrated Soldier borne/operated sensors and radios for critical applications; assess small, electromechanical components with greater efficiency and power density to support Soldier and Squad level battery recharging; investigate recoil, thermal and acoustic energy harvesting technologies that scavenge unused signatures from the Next Gen Squad Weapon to provide power for fire control technologies. ***FY 2021 Plans:*** Will develop Si-Anode based buttstock batteries (BSBs) for the Next Gen Squad Weapon that minimize weight and maximize energy; conduct component level Technology Readiness Level 5 verification and validation of these high capacity batteries in a laboratory environment; investigate advanced energy storage and power generation materials and components specifically targeted at increasing runtimes of digital Soldier devices; investigate energy storage, weight distribution, power distribution, and safety for the next generation squad weapons power/data rail and native battery; investigate advanced cathode materials and pairings to determine increase on the runtime of Soldier borne devices in small, lightweight, flexible form factors; mature components of small, power generation devices powered by logistically available fuels to enable integrated Soldier borne/operated sensors and radios for critical applications. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Materials & Component Technologies for Energy Independence ***Description:*** The effort develops technologies to substantially reduce the number of batteries required to accomplish dismounted Soldier/Squad mission objectives by developing more efficient power and thermal management for small systems and harvesting energy and alternative energy technologies thereby significantly reducing Soldier-borne load and logistics requirements for Soldier/Squad power and energy. ***FY 2020 Plans:*** Develop aqueous electrolytes and other high voltage electrolytes/additives for conformal, flexible, safe, abuse tolerant lithium ion and lithium metal batteries; research and develop a multifuel-fired power generator with high fuel efficiency and reduced noise signatures, emphasizing logistics fueled heat source, thermal selective emitter and photovoltaic cell; develop and design inductors and other power components using novel materials; explore technologies to harvest electrical power by converting and storing energy via kinetic, elastocaloric thermal materials and catalytic synthesis of fuel-like chemicals from indigenous resources; develop more efficient catalysts for carbon dioxide electroreduction to useful energy carriers; and develop higher efficiency plasmonic catalysts to catalyze the breakdown of fuels to produce usable energy. ***FY 2021 Plans:*** Will investigate optimized coupling between multifuel-fired heat sources and thermophotovoltaic converters for portable multifuel-fired power generators; research and develop multiplexed micro reactors and investigate at different scales for wearable or	-	5.037	5.348

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BD8 / *Soldier & Sm Unit Tactical Energy Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
portable multifuel-fired power generator heat sources; develop flexible and safe aqueous/gel batteries and validate use in diversified application platforms for follow-on robustness studies; investigate the solvation, transport, liquid structure, and interface/interphase of multivalent cation electrolytes; further extend the new halide-graphite intercalation chemistry to multivalent cations; investigate devices based on a series of new materials and chemistries in both aqueous, non-aqueous, and hybrid systems; investigate reversible Martensitic phase transformations in solid-state cooling materials such as nickel-titanium alloys and new architectures, and conduct experiments with advanced characterization techniques to enable future high-performance and silent operation for applications related to directed energy, pulse power, and Soldier wearable cooling; fund research on blue whirl combustion technology for harvesting energy from a broad range of liquid fuels at a much higher efficiency than currently possible; determine new catalytic materials and pyrolysis reactor process in one-step to produce useful chemicals/fuels as energy scavenger for compact energy power sources for robotic autonomous systems. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.416	-
Accomplishments/Planned Programs Subtotals	-	9.145	9.043

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BE1 / *Support Technology to Mission Command*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BE1: *Support Technology to Mission Command*	-	0.000	0.726	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.726

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602786A Warfighter Technology
* Project XW5 Small Unit Expeditionary Maneuver Technology

In FY21 this Project is being realigned to:
PE 0602146A Network C3I Technology
* Project AQ9 Expeditionary Data to Decisions Technology

A. Mission Description and Budget Item Justification

This Project investigates and designs technologies that support Soldier/Small Unit survivability, mobility, and combat effectiveness during mission command operations at operational and tactical levels in lethal and contested environments, enabling decentralized and dispersed operations in the future operating environment. This Project designs innovative mission command node platforms with enhanced mobility and agility, increased protection and survivability against electro-magnetic interference (EMI) and other threats, and rapid movement and emplacement, resulting in increased lethality and coordination of dispersed formations during operations and supporting resilient formations in multi-domain operations. Component technologies designed under this Project will transition to Advanced Technology Development efforts in the Soldier Lethality Modernization priority in support of decentralized and dispersed mission command operations in future operating environments and expeditionary maneuver in the Multi-Domain Operations Environment.

Work in this Project supports key Army needs and leverages/complements the technical research of several PEs to include PE 0601102A (Defense Research Sciences), and the following Projects within PE 0602143A (Soldier Lethality Technology): Project BB4 (Dismounted Soldier Survivability Materials), Project BD8 (Soldier & Sm Unit Tactical Energy Tech), Project AZ9 (Soldier Protection Advanced Tech - Detectability), PE 0603118A Soldier Lethality Advanced Technology / Project AZ8 (Soldier - Small Unit Detectability Adv Technology) and PE 0602712A (Countermine Systems) / Project H35 Camouflage and Counter-Recon Tech).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Small Unit Expeditionary Mission Command Research	-	0.693	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BE1 / *Support Technology to Mission Command*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort investigates and designs components of agile, modular, non-traditional Command Post platforms designed to enable the mission command network, supporting decentralized and distributed mission command operations in the future operating environment. Investigates material node platforms and other component concepts supporting rapid emplacement and displacement with enhanced survivability, mobility, signature management protection, and secured/non-degraded communication capabilities. Investigates and conducts experiments to validate component performance in a multi-domain battle operations. The large-footprint and logistics-intensive nature of current mission command systems compromise Soldier Lethality and mission effectiveness and do not provide the enhanced mobility and protection necessary to effectively execute mission command operations in the extremely expeditionary, multi-domain environment of the future. This research effort will enable tactical leaders to make timely decisions, integrate more seamlessly into the battlefield through a decrease in size, signature, and logistics burden, and will increase both maneuverability and survivability by enabling the development of agile Command Posts that support Multi-Domain Operations. ***FY 2020 Plans:*** Investigate tactical Command Post design and component concepts to identify individual component metrics that support mission command effectiveness based upon critical operational partner needs such as rapid emplacement, displacement and survivability in the future operating environment; conduct experiments on Command Post components for EMI protection and secure communications to validate component performance to allow defeat of adversary efforts to disrupt mission command operations, as well as to open and retain windows of advantage in the multi-domain environment. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** The funding in this effort was realigned to PE 0602146A (Network C3I Technology) / AQ9 (Expeditionary Data to Decisions Technology).			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.033	-
Accomplishments/Planned Programs Subtotals	-	0.726	-

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BE1 / *Support Technology to Mission Command*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army												Date: February 2020
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*				Project (Number/Name) BE3 / *Joint Service Combat Feeding Technology*			
COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BE3: *Joint Service Combat Feeding Technology*	-	0.000	3.996	4.109	-	4.109	4.073	4.764	4.817	4.817	0.000	26.576

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602786A Warfighter Technology
* Project H99 Joint Service Combat Feeding Technology

A. Mission Description and Budget Item Justification

This Project investigates and develops nutrient compositions and stabilization techniques to maximize the Warfighter's physical and cognitive performance on the battlefield, investigates technologies to enhance detection and identification capabilities of chemical and biological threats in foods, and develops innovative ration and field feeding technologies to reduce resupply requirements for the multi-domain battlefield. The Army serves as the Executive Agent for this Department of Defense (DoD) program, with oversight and coordination provided by the DoD Combat Feeding Research and Engineering Board.

Work in this PE is related to and fully coordinated with PE 0602787A (Medical Technology) / Project 869 (Warfighter Health Prot & Perf Stnds) to develop technologies and concepts; Army Additive Manufacturing Community of Practice to enable customization, increase readiness, and improve sustainment due to fabrication of end-use items at point of need; Office of the Assistant Secretary of Defense (OASD) Applied Research for Army Priorities (ARAP) to transition and develop materiel solutions in the synthetic biology and microbiome technical areas; Defense Health Agency (DHA) Joint Program Committee-5, which seeks to develop effective nutritional countermeasures against stressors and to maximize health, performance, and well-being; and Office of Navy Research (ONR) PE 0601153N Defense Research Sciences Biosciences program to evaluate nutritional countermeasures to physiological environmental extremes.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Joint Service Combat Feeding Technology	-	3.815	4.109
Description: This effort investigates, designs, and develops nutrient compositions and stabilization techniques to maximize the Warfighter's physical and cognitive performance on the battlefield. The effort investigates technologies to enhance detection and identification capabilities of chemical and biological threats in foods and develops innovative ration and field feeding technologies to reduce resupply requirements. Work in this area results in increased performance, less food-borne illness, and overall increased readiness of the Warfighter.			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BE3 / *Joint Service Combat Feeding Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2020 Plans: Identify and test nutritional interventions that prevent performance decrements associated with known degraded immune function and consequential weight loss in extreme environments; identify and test novel prophylactic nutrition to mitigate or prevent cause of illness in deployed troops globally such as gastrointestinal dysbiosis that affects operational readiness; investigate and design nutrient stabilization techniques to retain or improve quality of products when stored/utilized in environmental extremes and multi-domain battlefields to ensure that nutrients required for optimal performance are both retained and are bioavailable at the point of consumption; transition weight reduction concepts for Close Combat Assault Ration formulations for advanced technology demonstration; investigate chemical agent permeability in ration packaging in support of Chemical Biological Radiological Nuclear and Energy (CBRNE) threats; transition novel energy ration components to advanced development; develop and model food formulations that retain desired sensory and organoleptic (appearance, odor, flavor, texture) characteristics after processing, storage and distribution to enable the customization of nutrients tailored to each individual warfighter?s need based on real time health status and operational scenario for rapid recovery and/or mission preparation. ***FY 2021 Plans:*** Will continue investigation of nutritional factors affecting immune function and muscle recovery, and perform ex-vivo experimentation to identify gut microbiome effects on immune, gastrointestinal, and neurological health for preventing performance decrements in deployed troops; validate lipid oxidation analysis techniques to improve monitoring ability in ration components and ensure optimized nutrition; identify effects of high fat intake on physical performance to ensure optimal nutrient profiles in weight reduced rations; investigate microbial response to vacuum microwave drying and antimicrobials effects on Salmonella to maintain food safety; mature component technologies for reagent-less biosensors to decrease logistical burdens in multi-domain operations; continue investigation of food product production with additive manufacturing; and design and develop ration packaging system to improve cost and efficiency. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.181	-
Accomplishments/Planned Programs Subtotals	-	3.996	4.109

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BE3 / *Joint Service Combat Feeding Technology*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BE6 / *Reactive/Resp Surfaces & Matls-Soldiers & Sys*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BE6: *Reactive/Resp Surfaces & Matls-Soldiers & Sys*	-	0.000	2.745	6.317	-	6.317	3.021	3.153	3.555	3.591	0.000	22.382

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602105A Materials Technology
* Project H84 Materials

A. Mission Description and Budget Item Justification

This Project designs, fabricates, and assesses a variety of bio-based materials through the application of biotechnology advances to develop material capabilities that respond and adapt to a wide range of external stimuli and biological processes for protection, situational awareness, and sustainment. Innovative materials will be sought that are capable of sensing and responding, as well as adapting response, to a broad spectrum of environmental variables. Research will develop materials that are able to self-monitor, self-heal, and self-sustain. Research will explore new biology-based methods for controlled synthesis and assembly to create materials with precise chemistries, microstructures, properties, and responsive functionalities through controlled molecular placement, spatial architectures, and interfacial structures. These materials have potential to enable more survivable, situationally aware, lighter weight Soldier systems and electronics. Research conducted focuses on unique and/or novel material properties, developing models, materials characterization techniques, non-destructive testing methods and advanced fabrication/processing methodologies.

Work in this PE complements PE 0601102A (Defense Research Sciences) / Project AA3 (Single Investigator Basic Research), Project AA3 (Single Investigator Basic Research), Project AA7 (Mechanics and Ballistics), and Project AA5 (Biotechnology and Systems Biology) and informs PE 0603118A (Soldier Lethality Advanced Technology) / BB3 (Dismounted Soldier Survivability Equip/Tech Integ).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Bio-enabled Materials and Processes	-	2.621	2.984
Description: This effort conducts applied research through the application of biotechnology advances to develop materials with capabilities to respond and adapt to a wide range of external stimuli and biological processes. Investment in bio-enabled materials research allows for the design of materials that are capable of sensing and responding, as well as adapting to a broad spectrum of environmental variables with the ability to self-monitor, self-heal, and self-sustain. Investments in this area could lead to future			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BE6 / *Reactive/Resp Surfaces & Matls-Soldiers & Sys*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
applications in Soldier performance, situational awareness, protection and sustainment. Research from this effort has potential to transition to multiple end items and applications. ***FY 2020 Plans:*** Investigate the integration of rapidly selected peptide reagents for applications in improved sensors for human performance and situational awareness; investigate a more information-driven peptide reagent design process drawn from previous studies; and design and synthesize biological materials, including a focus on diatoms for improved logistics, increased robustness and new capabilities in gradient / hierarchical materials with nanoscale resolution of features to control optical, structural and reactive performance for potential application in adaptive coatings for vehicles. ***FY 2021 Plans:*** Will investigate chemically and structurally diverse biological building blocks (peptide-based) for advanced sensing applications, protection, and interface/assembly of hierarchical materials; investigate advanced coatings and materials assembly utilizing bio-derived and bio-composite materials for advanced sensing and protection (e.g. situational awareness, counter-biocorrosion, and biological inhibitors) and electro-magnetic applications such as antennas, lenses, and optically triggered skins/coatings; identify targets and design strategy for accelerated degradation of high value assets (electronic components, protective coatings), logistics reduction (e.g., accelerated repair and reclamation of rare-earth elements), and next generation anti-tamper technologies. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increase to further investigate novel molecular biology.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.124	-
Title: Scalable and On-Demand Production of Novel Molecules ***Description:*** This effort conducts applied research through the investigation of new methods to produce novel biological molecules. Typical customized molecule production is extremely expensive and difficult to achieve. Investment in synthetic biomanufacturing techniques will further the applicability and widespread use of novel molecules to further Warfighter performance.	-	-	3.333

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BE6 / *Reactive/Resp Surfaces & Matls-Soldiers & Sys*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2021 Plans: Will investigate computational and experimental tools facilitating the use of molecular biology to produce novel molecules of interest. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increase to maximize gains from unanticipated acceleration in this technology area.			
Accomplishments/Planned Programs Subtotals	-	2.745	6.317

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BE8 / *Synthetic Training Environment (STE) Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BE8: *Synthetic Training Environment (STE) Technology*	-	0.000	15.438	14.133	-	14.133	16.207	15.787	15.963	15.964	0.000	93.492

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602308A Advanced Concepts and Simulation
* Project C90 Advanced Distributed Simulation
* Project D02 Modeling and Simulation For Training And Design
PE 0602716A Human Factors Engineering Technology
* Project H70 Human Factors Eng Sys Dev

A. Mission Description and Budget Item Justification

This Project designs and develops technologies supporting the Army's Synthetic Training Environment (STE). The Synthetic Training Environment (STE) is the next generation holistic collective training capability that will train units where they will fight, with whom they will fight with, and in complex operational environments to include dense urban and sub-terrain; within the entire range of combined arms maneuver tasks in support of Multi- Domain Operations. STE Information Systems (STE-IS) delivers the Common Synthetic Environment consisting of Global Terrain/One World Terrain (OWT), Training Simulation Software (TSS), and Training Management Tools (TMT). The STE will be available where training occurs (home station, combat training centers, armories, institutions, shipboard, deployed) and will include Air and Ground Reconfigurable Virtual Collective Trainers (RVCTs), a Soldier/Squad Virtual Training (S/SVT), and a live training capability. The STE will be cloud-enabled, compatible with the Army Enterprise Network, and service-based through the Common Operating Environment, including Live and Constructive. The STE will provide the realistic repetitions necessary to fight 25 bloodless battles before the first battle; a Secretary of Defense priority.

This effort is coordinated with work done in PE 0603118A (Soldier Lethality Advanced Technology) / Project BE9 (Synthetic Training Environment (STE) Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas, the Army Modernization Strategy and supports the STE Cross Functional Team efforts.

Work in this Project is performed by the United States Army Futures Command (AFC) and at the Institute for Creative Technologies (ICT) University Affiliated Research Center (UARC) at the University of Southern California

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Innovative Synthetic Training Technology	-	7.845	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BE8 / *Synthetic Training Environment (STE) Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort investigates and designs methods of applying Artificial Intelligence (AI) into the STE to simulate a fully immersive environment in large urban settings with a population of adaptable, noncombatant virtual human agents for increasing the realism and complexity of training scenarios. In addition, develops tools, techniques and technologies for improving the immersion of human senses within simulation environments with the goal of creating enhanced realism within the simulated environment. ***FY 2020 Plans:*** Investigate artificially intelligent individuals and groups of virtual humans as role-players to support increased scenario complexity and social interactions with trainees and reduce the need for costly live role-players and simulation support teams; develop artificially intelligent virtual humans with adaptable human behaviors driven by their own beliefs, desires, and intentions; apply methods for natural language understanding allowing for social dialogue with the virtual humans. Expand and apply knowledge in cognitive architectures, social simulations, and virtual human research areas to provide design, development, and improvement of new technology products focused on the accurate and immersive inclusion of the human dimension in virtual and mixed reality context. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding realigned to PE 0602143 (Soldier Lethality Technology) / BC7 (Training Technology (Other than STE)).			
Title: STE One World Terrain ***Description:*** This effort investigates and designs tools and methods to improve the speed and fidelity of a terrain capability that provides a representation of the globe, fully accessible through the Army network and usable by all simulation trainers; develops complex representations (including megacities and subterranean) of the operational environment and the Multi-Domain battlefield in synthetic training environments. ***FY 2020 Plans:*** Research alternative data sources for applicability to modeling & simulation (M&S), with emphasis on providing accurate representation (geometry) and visuals (quality at ground level); investigate alternative data sources to improve availability of rich data for next-generation terrain representation; research data fusion techniques by exploiting data sources and processed data to demonstrate a behavior pattern of disparate data over the same geographic area, initiating the need for automated processes to combine and de-conflict different data into a single, consistent dataset for end-use applications; and develop tools and procedures for merging data sources into a single, consistent dataset. ***FY 2021 Plans:*** Will develop a whole world terrain at low to medium resolution using available data; evaluate alternative data sources to fill gaps; develop tools to rapidly process source data into a single representation that serves all application needs; develop and investigate	-	1.934	5.832

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BE8 / *Synthetic Training Environment (STE) Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
a processes for generating fully attributed hi-resolution terrain insets such as underground geometry, key civilian infrastructure components, complex road networks, hydrological features, and complex structures. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increase to further experiments testing the data gathering and integration necessary to build the One World Terrain.			
Title: STE Training Management Tool ***Description:*** This effort investigates Adaptive Training (AT) methods to facilitate authoring, distribution, management, and evaluation of tailored instruction for both individuals and teams; and evaluates the impact of training and educational tools / methods on comprehension, reasoning, learning, performance, retention, and transfer of knowledge and acquired skills to assess Training Effectiveness (TE) in Synthetic Training Environments. ***FY 2020 Plans:*** Validate a base authoring concept for adaptive training; expand concepts for authoring tools, team modeling, team instruction, and Army team domains to support the development of team (unit level) tutoring systems; mature training strategies for autonomous software systems; and develop tools to rapidly author scenario variants to customize training. Develop models and tools for automated measurement of critical training outcomes for selected individual and collective tasks; and explore and identify new sensors for measuring effectiveness in collective training events. ***FY 2021 Plans:*** Will design and develop natural language artificial intelligence (AI) processing techniques for small team verbal communications during task execution; develop proof of principle for automating team performance assessments and for actionable automated after action review (AAR) feedback to teams, leaders, and instructors; develop a robust intelligent team adaptive training capability to maximize training outcomes at point of need; develop AI methods grounded in learning science to support self-optimizing systems that produce skill retention and transfer into the operational environment; conduct experiments to validate team performance measures; assess the effectiveness of different machine learning approaches to facilitate automated authoring of scenario based training for individuals and teams; develop models for assessing competencies of individuals and teams using a combination of live, virtual, and constructive training events in militarily relevant domains; investigate the use of physiological measures as a means of improving automated adaptation of training and for assessing training outcomes, predicting training transfer, and providing real-time feedback to instructors and students during the execution of individual and collective training. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	4.958	5.291
Title: STE Training Simulation Software	-	-	3.010

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BE8 / *Synthetic Training Environment (STE) Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort designs and develops technologies that support Multi-Domain Operations modeling and maturing of simulation configuration and scalability components for collective training. In addition, designs and develops technologies that allow the synthesis of robust military behaviors that enable the scaling of Synthetic Training Environment (STE) collective training configurations and delivery to the Point of Need through the exploitation of emerging computing and networking technologies that optimize computing architectures for integrating components (models, behaviors, data, etc.) of the Training Simulation Software (TSS). ***FY 2021 Plans:*** Will investigate autonomous, artificially intelligent agents that adapt to changing battlefield conditions, friendly forces, non-combatants, and enemy threats in a military relevant virtual training environment; investigate multi-resolution modeling applications such as Live, Virtual, and Constructive (LVC) experimentation utilizing AI enabled attributes; and design and develop cutting-edge M&S methods to enable the reuse and development of new Army and Department of Defense (DoD) STE-ready models for Multi-Domain Operations in support of System of Systems (SoS) analysis, experimentation, technology tradeoffs, capability assessments, concept development, and training. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increased from PE 0602145A (Next Generation Combat Vehicle Technology) / BF6 (Crew Augmentation and Optimization Tech) to support AI based development efforts for intelligent character behaviors.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.701	-
Accomplishments/Planned Programs Subtotals	-	15.438	14.133

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army												Date: February 2020
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*				Project (Number/Name) BP9 / *Soldier Lethality Technologies (CA)*			
COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BP9: *Soldier Lethality Technologies (CA)*	-	0.000	30.626	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	30.626

Note

Congressional Interest Item funding provided for Soldier Lethality Technologies.

A. Mission Description and Budget Item Justification

This project is for congressional increases that support applied research in support of Soldier Lethality, where the Soldier and Squad are treated as an integrated combat platform. The fundamental challenge is to overcome an erosion in close combat overmatch relative to the pacing threats identified in the National Defense Strategy. This program increase leverages science, technology, and human potential to achieve the overmatch necessary to maneuver, isolate, and defeat our adversaries in any environment.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Medical simulation and training ***FY 2020 Plans:*** Medical simulation and training	-	3.626
Congressional Add: Active and passive camouflage concealment and deception ***FY 2020 Plans:*** Active and passive camouflage concealment and deception	-	3.000
Congressional Add: Human systems integration ***FY 2020 Plans:*** Human systems integration	-	10.000
Congressional Add: Expeditionary mobile base camp technology ***FY 2020 Plans:*** Expeditionary mobile base camp technology	-	2.000
Congressional Add: SOCOM communications capability ***FY 2020 Plans:*** SOCOM communications capability	-	2.500
Congressional Add: Soldier Lethality Technologies Program Increase ***FY 2020 Plans:*** Soldier Lethality Technologies Program Increase	-	5.000
Congressional Add: Harnessing Emerging Soldier Lethality Technology Research ***FY 2020 Plans:*** Harnessing Emerging Soldier Lethality Technology Research	-	4.500
Congressional Adds Subtotals	-	30.626

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BP9 / *Soldier Lethality Technologies (CA)*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / *Soldier Lethality Technology*	Project (Number/Name) BR9 / *Personnel & Airdrop Safety Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BR9: *Personnel & Airdrop Safety Technology*	-	0.000	4.098	3.725	-	3.725	3.519	3.951	3.615	3.615	0.000	22.523

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602786A Warfighter Technology
* Project XW5 Small Unit Expeditionary Maneuver Technology

A. Mission Description and Budget Item Justification

This Project funds the research and investigation of component technologies to enhance cargo and personnel airdrop capabilities for global precision delivery, rapid deployment, and insertion for force projection into hostile regions. Areas of emphasis include parachute technologies, parachutist injury reduction, precision offset aerial delivery, soft landing technologies, and airdrop simulation. Technologies support the Soldier Lethality Army Modernization Priority. New operational concepts call for increased precision of personnel and cargo in austere environments in which small units are dispersed and logistical supply is limited. The Army requires enhanced payload extraction and other increased capabilities to support the airdrop requirement for current and future vehicles exceeding aircraft payload weight capacity. TheU.S. Army Airborne Board (Chaired by the XVIII Airborne Corps Commanding General) identified increased payload capabilities as a critical requirement to support the mission readiness profile for the Global Response Force (GRF), and will support Joint Forcible Entry requirements while maximizing the capacity of a C-17 aircraft.

Work in this Project supports key Army needs and complements the technical research of several PEs to include PE 0601102A (Defense Research Sciences), PE 0602143A (Soldier Lethality Technology) / Project BD6 (Soldier Sys Interfaces/ Integration- Sensor Tech), and PE 0603118A (Soldier Lethality Advanced Technology) / Project BE5 (Personnel & Airdrop Safety Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Personnel & Airdrop Safety Technology	-	3.912	3.725
Description: This effort investigates technologies that enhance payload extraction, which will allow current vehicles to be dropped with more armor and support equipment, and reduce the design constraint on future vehicles that have airdrop as an operational requirement, increase parachute gliding capabilities, and mature delivery accuracy of cargo aerial delivery systems that support varying payload weights. Research in the area of novel parachute materials will provide increased capabilities for cargo and personnel aerial delivery systems. This effort will support an investigation of new Modeling and Simulation (M&S) tools in order to develop validation methods for airdrop concepts. This effort also investigates technologies that advance airborne personnel			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602143A / *Soldier Lethality Technology*	**Project (Number/Name)** BR9 / *Personnel & Airdrop Safety Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
insertion safety requirements to modernize the Airborne Soldier and provide the ability to effectively execute the airborne mission through reducing safety risk and increasing capabilities. ***FY 2020 Plans:*** Explore multi-modal sensing methods and control techniques to study the efficacy of precision aerial delivery via a variety of decelerator systems deployed via conventional and non-traditional methods in GPS denied/degraded and anti-access / area denial (A2/AD) environments to address future operational challenges; investigate augmentation of personnel airdrop systems to enhance airborne jumper performance while expanding operational footprint opportunities; conduct experiments fundamental to understanding aerodynamic characteristics of airdrop systems; and develop advanced modeling techniques applicable to the full spectrum of the acquisition process to improve airdrop safety and reduce the cost of future development efforts. ***FY 2021 Plans:*** Will conduct research into sensing technologies that augment personnel or autonomous cargo airdrop systems, enabling accurate, reliable insertion and resupply missions across a broad scope of operational conditions and non-traditional airdrop environments; examine new parachute designs and avionics necessary to facilitate maximum mission effectiveness conducted across an array of technologies and modalities using analytical, numerical, and experimental methods. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.186	-
Accomplishments/Planned Programs Subtotals	-	4.098	3.725

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	**Date:** February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	0.000	143.899	28.047	-	28.047	31.666	31.807	32.889	33.387	0.000	301.695
BK7: *Robotics for Engineer Operations Technology*	-	0.000	9.998	6.265	-	6.265	3.243	2.431	1.768	5.995	0.000	29.700
BL1: *Materials and Manufacturing Research Technology*	-	0.000	8.127	10.270	-	10.270	10.499	10.818	10.943	11.054	0.000	61.711
BL2: *Explosives Forensics Technology*	-	0.000	1.542	1.571	-	1.571	1.602	1.634	1.653	1.670	0.000	9.672
BL4: *Countermine Technology*	-	0.000	4.244	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.244
BL5: *Expedient Passive Protection Technology*	-	0.000	4.119	1.467	-	1.467	2.030	5.948	4.606	3.507	0.000	21.677
BL7: *Power Projection in A2AD Environments Technology*	-	0.000	2.766	1.913	-	1.913	3.190	1.828	2.872	0.000	0.000	12.569
BL9: *Protection from Advanced Weapon Effects Technology*	-	0.000	4.403	3.957	-	3.957	7.393	4.346	5.332	5.332	0.000	30.763
BN8: *Ground Technology Materials(CA)*	-	0.000	108.700	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	108.700
CA9: *Predictive Maintenance*	-	0.000	0.000	2.604	-	2.604	3.709	4.802	5.715	5.829	0.000	22.659

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is realigned with continuity of effort from the following PEs:
* 0602105A Materials Technology
* 0602622A Chemical, Smoke, and Equipment Defeating Technology
* 0602705A Electronics and Electronic Devices
* 0602712A Countermine Systems
* 0602720A Environmental Quality Technology
* 0602784A Military Engineering Technology

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*

A. Mission Description and Budget Item Justification

This PE researches efforts that support and enable the Army's modernization priority for the Next Generation of Combat Vehicles including systems for the deployment and sustainment of ground movement and maneuver. This PE designs and validates technologies that are necessary and foundational for legacy and future ground movement, maneuver and protection of Soldiers and systems.

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

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

Work in the Project supports the Army Science and Technology Ground portfolio.

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

Work in this PE complements PE 0602145A (Next Generation Combat Vehicle Technology), PE 0603119A (Ground Advanced Technology), PE 0603462A (Next Generation Combat Vehicle Advanced Technology), PE 0602143A (Soldier Lethality Technology) and PE 0603118A (Soldier Lethality Advanced Technology).

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	0.000	35.199	29.837	-	29.837
Current President's Budget	0.000	143.899	28.047	-	28.047
Total Adjustments	0.000	108.700	-1.790	-	-1.790
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	108.700			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	-1.790	-	-1.790

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2019	FY 2020
Project: BN8: *Ground Technology Materials(CA)*		
Congressional Add: *Environmental Quality Enhanced Coatings*	-	5.000
Congressional Add: *Environmental Friendly Coatings Technology*	-	3.000
Congressional Add: *Additive Manufacturing for Artificial Intelligence and Machine Learning*	-	5.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2019	FY 2020
Congressional Add: *Earthen Structures Soil Enhancement*	-	4.000
Congressional Add: *M1 Abrams Tank Track System*	-	2.200
Congressional Add: *High Performance Polymers*	-	5.000
Congressional Add: *Materials Manufacturing Processes*	-	6.000
Congressional Add: *Highly Durable Advanced Polymers for Lightweight Armor*	-	8.000
Congressional Add: *Cellulose Nanocomposite Research*	-	5.000
Congressional Add: *Countermine Program*	-	5.000
Congressional Add: *Materials Research*	-	17.500
Congressional Add: *Additive Manufacturing and Materials Processing*	-	15.000
Congressional Add: *Cold Weather Military Research*	-	3.000
Congressional Add: *Cold Spray Technologies*	-	15.000
Congressional Add: *Center for Research in Extreme Batteries*	-	10.000
Congressional Add Subtotals for Project: BN8	-	108.700
Congressional Add Totals for all Projects	-	108.700

Change Summary Explanation

FY20 increase related to $108.700 million of Congressional Add funding.

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BK7 / *Robotics for Engineer Operations Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BK7: *Robotics for Engineer Operations Technology*	-	0.000	9.998	6.265	-	6.265	3.243	2.431	1.768	5.995	0.000	29.700

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602784A Military Engineering Technology
* Project T41 Mil Facilities Eng Tec
* Project T45 Energy Tec Apl Mil Fac
PE 0602720A Environmental Quality Technology
* Project 048 Ind Oper Poll Ctrl Tec

A. Mission Description and Budget Item Justification

This research investigates and develops standoff robotic capabilities for Combat Engineers to reduce Soldier/Engineer risks and fatalities while conducting activities essential to shaping the environment. It will close the gaps between commercial construction equipment and the requirements of the future Engineer Force to support maneuver, movement, and sustainment. This research will develop the capability to generate a near real-time site model with appropriate engineering details to allow unmanned shaping of the environment through physical interaction (e.g. push, pull, lift, or dig). This effort will also develop the requisite mission planner and task execution controller that accepts input from the user and provides suggestions and feedback based on updates to the site model, reporting from hardware agents, and resource allocation logic. The end state goal is the development of beyond visual line of sight teleoperation and semiautonomous capabilities allowing Engineer robotic support to match pace in near term and future combat environments. This effort will support the development, testing, and evaluation of prototypical robotic Combat Engineer equipment. This Project develops modeling and simulation tools that represent realistic states for Engineer robotic operations and develops and assesses semi-autonomous and autonomous construction equipment technologies needed for remote control Engineer operations.

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

Work in this Project supports the Army Science and Technology Ground Portfolio.

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

Work in this Project is coordinated with PE 0603462A (Next Generation Combat Vehicle Advanced Technology) and complements PE 063119A (Ground Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Dynamic Site Characterization	-	2.132	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BK7 / *Robotics for Engineer Operations Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort develops the capability to dynamically characterize the environment in which robotic Engineer equipment will operate through implementation of multi-modal sensing, sensor data fusion, and object detection and classification. ***FY 2020 Plans:*** Adapt, modify, and improve object detection and classification capability to specifically support Combat Engineer tasks as well as develop capabilities for detailed engineering characteristics for soils and classification of materials both on the surface and subsurface. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 the Dynamic Site Characterization effort continues in the Beyond-Visual-Line-of-Sight (BVLOS) Teleoperated Engr Ops effort in this Project.			
Title: Mission Planning and Task Execution Control ***Description:*** This effort develops a mission planning and task execution control capability to enable unmanned robotic Engineer equipment operations. This capability will provide a near real time operational view of the area of interest and will convert mission planning directives into commands for the robotic equipment. ***FY 2020 Plans:*** Develop the tools for the visualization of the site model to allow an operator to view, explore, and utilize site data. In addition, it will create a user interface for an operator to input mission planning directives, machine control, and view task status. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 the Mission Planning and Task Execution Control effort continues in the BVLOS Teleoperated Engr Ops effort in this Project.	-	3.132	-
Title: Integration Prototype Model Development ***Description:*** This effort develops remote control protocols and processes for testing of construction equipment to assess suitability for use during engineer operations; assesses commercially available autonomy solutions from transportation and construction industries to develop enhanced semi-autonomous and autonomous equipment technology; and develops simulation tools for coordinated, multi-equipment operations. ***FY 2020 Plans:*** Build a hardware-in-the-loop synthetic environment for development and testing of control algorithms and adapt, modify, and expand semi-autonomous navigation capabilities to facilitate one operator controlling multiple types of equipment. ***FY 2020 to FY 2021 Increase/Decrease Statement:***	-	4.613	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BK7 / *Robotics for Engineer Operations Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
In FY21 the Integration Prototype Model Development effort continues in the BVLOS Teleoperated Engr Ops effort in this Project.			
Title: Beyond-Visual-Line-of-Sight Teleoperated Engr Ops ***Description:*** This effort develops site characterization technologies, equipment localization technologies, equipment tools, and controls protocols to support remote control and semi-autonomous engineering operations and develops modeling and simulation tools to support remote operations. ***FY 2021 Plans:*** Will develop Combat Engineer specific library for object classification and identification to allow for greater fidelity in semi-autonomous site characterization; will develop site localization technologies for Engineer equipment operating in Global Positioning System denied environments; will develop machine learning and artificial intelligence protocols unique to construction equipment tool manipulation and execution; will develop equipment controls and control interfaces to allow multiple pieces of equipment to be operated/overseen by one operator. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Work in the BVLOS Teleoperated Engr Ops effort was previously conducted under Dynamic Site Characterization, Mission Planning and Task Execution Control, and Integration Prototype Model Development efforts in this Project.	-	-	6.265
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.121	-
Accomplishments/Planned Programs Subtotals	-	9.998	6.265

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL1 / *Materials and Manufacturing Research Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BL1: *Materials and Manufacturing Research Technology*	-	0.000	8.127	10.270	-	10.270	10.499	10.818	10.943	11.054	0.000	61.711

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602105A Materials Technology
* Project XW4 Manufacturing Science
PE 0602705A Electronics and Electronic Devices
* Project H94 Electronics and Electronic Devices

A. Mission Description and Budget Item Justification

This Project links materials research, manufacturing processes, and design to enable higher quality additive manufacturing products for Army applications through the development of high performance feedstock materials (polymers, metals, and ceramics), physics-based process models, and in-situ process monitoring. Integration of these tools with process models enables real-time control and manipulation of materials structure and properties to produce three-dimensional hybrid electronics packaging, power and energy sources and converters and new materials/structures for protection. The goal of this work is to develop robust physics-based models to optimize material properties, structures, and manufacturing processes for Army applications in protection, maneuver, power, sensing, and signature management necessary to rapidly respond to emerging and unknown threats in a battlefield environment.

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 Ground and Next Generation Combat Vehicle.

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

This work is done in coordination with PE 0602145A (Next Generation Combat Vehicle Technology), 0602143A (Soldier Lethality Technology) and 0603118A (Soldier Lethality Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Agile Expedient Manufacturing	-	2.227	-
Description: This effort researches developing manufacturing processes to accelerate the rate of innovative material adaptations (protection, power, sensing, and signature management) necessary to rapidly respond to emerging and unknown threats in a battlefield environment. Efforts include the development of innovative materials technologies through combinations of additive			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL1 / *Materials and Manufacturing Research Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
and subtractive manufacturing, direct write processes, coupled electro-magnetic fields, and other hybrid processes, as well as the development of robust predictive modeling and simulation tools linking manufacturing processes with materials structure, properties, and performance to enable the design and production of optimal materials at the point of need using available materials, energy sources, etc. ***FY 2020 Plans:*** Will develop novel chemistries and incorporate into ambient reactive extrusion processes to print energetic polymer propellants with optimal architectures. Will develop material processes to control and modify interfaces to enable three-dimensional hybrid electronics packaging that integrates microprocessors, amplifiers, three-dimensional antennas, and sensors for Army applications. Will investigate coupling electromagnetic fields to metal additive manufacturing processes to control specific microstructures in Magnesium alloys. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 the Agile Expedient Manufacturing effort moves to Additive Manufacturing Research to combine all Additive Manufacturing within this Project.			
Title: Power and Energy ***Description:*** This effort focuses on the design and characterization of chemistries, materials, and components for advanced batteries, fuel reformers, and fuel cells. Potential Army applications include hybrid power sources, smart munitions, hybrid electric vehicles, and soldier power applications. This effort also investigates the applicability of photosynthesis to provide fuel and electricity for soldier power applications, and investigate silicon carbide power module components that could enable compact, high-efficiency, high-temperature, and high-power density converters for motor drive and pulse power applications. ***FY 2020 Plans:*** Will develop electrolytes for high-voltage cathodes that will enable the transition of next generation high-energy batteries to the North Atlantic Treaty Organization (NATO) standard 6T format; will explore the feasibility of using biomimetic electrochemical devices for neuromorphic computing to enable artificial intelligence; will develop more efficient oxygen evolution catalysts for water electolyzers to generate hydrogen for fuel cells; and will investigate thermal and liquid reserve battery chemistries that extend operational duration of the battery while maintaining the 30-year shelf life requirement. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 the Power and Energy effort is realigned to Energy Sources and Storage within this Project.	-	1.609	-
Title: Additive Manufacturing Research ***Description:*** This effort researches new additive manufacturing (AM) capabilities that enable production of lightweight materials for protection, lethality, and maneuverability that cannot be produced through traditional manufacturing methods. Efforts include	-	3.922	8.483

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL1 / *Materials and Manufacturing Research Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
the development of new feedstock materials engineered specifically for low-volume additive processes to produce net-shape materials with desired properties and functionalities; integrated process models and real-time monitoring for closed-loop control and production of lightweight materials with optimal architectures, property gradients, and interfaces; and design optimization capabilities that connect materials and manufacturing to access the full design space enabled by additive manufacturing. ***FY 2020 Plans:*** Will quantify processing-structure-property relationships in additively manufactured ultra-high strength steel alloys designed specifically for laser-based AM processes; will validate continuum scale model of laser-metal powder bed AM process and mesoscale phase field model of microstructure development; will develop optimal non-laser based AM process to retain unique micro/nanostructures in nanocrystalline metal feed stocks; will create novel additive processes to incorporate novel particulate and high aspect ratio fillers into AM polymer composites. ***FY 2021 Plans:*** Will build upon prior metallic suspension chemistries to demonstrate electrical interconnect deposition capability for ambient reactive extrusion processes; demonstrate high conductivity, high resolution metallic inks to enable chip to chip interconnect and board level integration; demonstrate modified interfaces into three-dimensional hybrid electronics; develop improved performance for the integrated microprocessors, amplifiers, three-dimensional antennas, and sensors for Army applications; investigate use of electromagnetic fields in metal additive manufacturing processes to control specific microstructures in Magnesium alloys for structural and protection uses. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 the Agile Expedient Manufacturing effort in this Project is realigned to combine all Additive Manufacturing-related efforts within this Project in this effort.			
Title: Energy Sources and Storage ***Description:*** This effort focuses on the design and characterization of chemistries, materials, and components for advanced batteries, fuel reformers, and fuel cells. Potential Army applications include hybrid power sources, smart munitions, hybrid electric vehicles, and soldier power applications. This effort also investigates the applicability of photosynthesis to provide fuel and electricity for soldier power applications, and investigate silicon carbide power module components that could enable compact, high-efficiency, high-temperature, and high-power density converters for motor drive and pulse power applications. ***FY 2021 Plans:*** Will develop electrolytes for high-voltage cathodes with high capacity silicon anode that will enable the transition of next generation high energy dense, safe batteries for Soldier use; synthesize and develop highly active low-cost catalysts for fuel production and to use in fuel cell and power conversion applications; investigate modeling of spin activated liquid reserve batteries	-	-	1.787

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL1 / *Materials and Manufacturing Research Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
to explore the design space as it relates to requirements for energy, activation times, and environmental conditions for future munition systems. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort is realigned from the Power and Energy effort in this Project.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.369	-
Accomplishments/Planned Programs Subtotals	-	8.127	10.270

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL2 / *Explosives Forensics Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BL2: *Explosives Forensics Technology*	-	0.000	1.542	1.571	-	1.571	1.602	1.634	1.653	1.670	0.000	9.672

Note

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

A. Mission Description and Budget Item Justification

This Project investigates and develops analytical methods for military explosives, homemade explosives (HME), HME precursors, and residue analysis for forensics attribution purposes. This project pursues research in signatures and algorithms required to provide improved residue analysis of explosives and precursor materials to enable integration into chemical and explosive hazard detection equipment for the warfighter.

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 Ground Portfolio.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Forensic Analysis of Explosives Signatures Applied Research	-	1.472	1.571
Description: This effort investigates forensics analytical methods for military explosives, HME, HME precursors, and residue analysis for attribution.			
FY 2020 Plans: Will investigate Photonic Integrated Circuits (PIC) for chemical sensing of explosives, narcotics, and other chemicals of interest for forensic analysis and personnel borne detectors. Will investigate novel materials to enhance selectivity in explosives detection.			
FY 2021 Plans: Will develop analytical methods for forensic analysis of explosives and other chemical hazards with the objective of assigning attribution to include collection, preparation, instrumental analysis and advanced statistical techniques; Will provide solutions for analytical problems encountered by expeditionary laboratories based on the research performed in this task.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL2 / *Explosives Forensics Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.070	-
Accomplishments/Planned Programs Subtotals	-	1.542	1.571

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / *Ground Technology*	Project (Number/Name) BL4 / *Countermine Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BL4: *Countermine Technology*	-	0.000	4.244	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.244

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602712A Countermine Systems
* Project H24 Selectable Neutralization and Breaching Technology

In Fiscal Year 2021 (FY21) this Project is being realigned to:
PE 0602145A Next Generation Combat Vehicle Technology
* Project BF9 Sensors for Autonomous Operations and Surv Tech

A. Mission Description and Budget Item Justification

This Project designs and develops selectable explosive hazard (EH) (i.e., mine, minefield, improvised explosive device) neutralization technologies combined with detection confirmation sensor capabilities to provide a future integrated detection and neutralization capability in support of both manned and unmanned mounted route clearance and conventional mine breaching operations.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy. Work in this Project supports Army Science and Technology Ground Portfolio and Soldier Lethality modernization priorities.

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

This Project is coordinated with PE 0602145A (Next Generation Combat Vehicle Technology), 0602143A (Soldier Lethality Technology), 0603462A (Next Generation Combat Vehicle Technology Advanced Technology) and 0603118A (Soldier Lethality Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Countermine Technology	-	4.051	-
Description: Designs and develops selectable explosive hazard neutralization technologies combined with detection confirmation sensor capabilities to provide a future integrated detection and neutralization capability in support of both manned and unmanned mounted route clearance and conventional mine breaching operations. Products of this effort include sensor components for high reliability confirmation, cueing algorithms that produce repeatable and accurate registration coordinates for neutralization, and trade off analysis of candidate neutralization techniques to achieve a desired neutralization order of magnitude (low or high order detonation).			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL4 / *Countermine Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will design EH neutralization techniques and set parameters of confirmation sensors; will mature laser, radio frequency and microwave sources to validate neutralization techniques. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 funding in this Project was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / BF9 (Sensors for Autonomous Operations and Survivability Technology) to meet higher priority modernization needs.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.193	-
Accomplishments/Planned Programs Subtotals	-	4.244	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL5 / *Expedient Passive Protection Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BL5: *Expedient Passive Protection Technology*	-	0.000	4.119	1.467	-	1.467	2.030	5.948	4.606	3.507	0.000	21.677

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602720A Environmental Quality Technology
* Project 835 Military Med Environ Crit
PE 0602784A Military Engineering Technology
* Project T40 Mobility/Weapons Effects Technology

A. Mission Description and Budget Item Justification

This Project designs and develops rapidly deployable passive protective solutions; algorithms for decision support applications and software; and tactics, techniques, and procedures to increase the survivability of personnel, critical assets, and facilities. Through experimental and computational investigation and design, this project develops force protection technologies for complex and urban environments. This Project also develops expedient solutions and decision support applications for protection against advanced energetic threats and large caliber rockets, missiles, and other emerging weapons.

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 Ground Portfolio.

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

Work in this Project complements PE 0603119A (Ground Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Integrate Novel Materials for Tone Down Applications	-	0.330	-
Description: This effort utilizes native vegetation as an unconventional countermeasure for Army concealment. Work includes identification of spectral properties for infrared disruption, and inclusion of additive materials for tone-down applications.			
FY 2020 Plans: Produce libraries of native vegetation, soil, materials, and spectral signal property information for incorporation into tone-down applications to provide enhanced living concealment based on geographical regions. Deliver suite of fully characterized			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL5 / *Expedient Passive Protection Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
formulations for use in unconventional countermeasures to include risk guidance on application hazards associated with material debris. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 work in this effort transitions to Protection Against High Trajectory Large Caliber Rocket and Missile Threats efforts in this Project			
Title: Force Protection in the Urban Environment ***Description:*** This effort develops force protection solutions for urban environments and computational test bed capabilities to develop advanced materials and expedient protective solutions; develops rapidly deployable protection systems; decision support applications and software; and tactics, techniques, and procedures to provide protection with consideration for a complex three-dimensional threat. ***FY 2020 Plans:*** Will conduct investigations to develop blast stagnation, blast reduction, overhead cover design, and ballistic protection algorithms; will develop an expedient retrofit kit for existing buildings and rapidly deployable force protection; will investigate a methodology for rapidly closing subterranean features. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Work in this effort transitions to the Protection Against High Trajectory Large Caliber Rocket and Missile Threats effort in this Project in FY21.	-	3.775	-
Title: Protection Against High Trajectory Large Caliber Rocket and Missile Threats ***Description:*** This effort investigates high trajectory large caliber rocket and missile weapon effects on critical assets and facilities and develops expedient force protection solutions for these new weapon threats. These solutions include the application of novel protective materials and designs. This effort develops and validates deployable protection systems against these threats and develops decision support tools to aid the warfighter in selecting protective positions. ***FY 2021 Plans:*** Will investigate effects of high trajectory large caliber rockets and missiles on legacy protective systems and new conceptual passive protection designs. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Work in this effort was previously conducted under the Force Protection in the Urban Environment and Integrate Novel Materials for Tone Down Applications efforts in this Project.	-	-	1.467
Title: FY 2020 SBIR/STTR Transfer	-	0.014	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL5 / *Expedient Passive Protection Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	-	4.119	1.467

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL7 / *Power Projection in A2AD Environments Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BL7: *Power Projection in A2AD Environments Technology*	-	0.000	2.766	1.913	-	1.913	3.190	1.828	2.872	0.000	0.000	12.569

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602784A Military Engineering Technology
* Project T40 Mobility/Weapons Effects Technology

A. Mission Description and Budget Item Justification

This Project develops remote assessment technologies to determine entry and maneuver corridors, develops site selection tools and decision support technologies for all climates in all season conditions including aviation site selection tools, enhanced automated route reconnaissance technologies, mobility models for extreme climates, and road capacity assessment technologies. These technologies reduce reliance on manned on-site reconnaissance for projection platform assessments and provide all season capacity predictions to ensure air and ground battlespace entry and maneuver. This Project also designs and develops material solutions to repair, rebuild and construct infrastructure required for movement and maneuver in highly contested, complex operational environments such as Anti-Access/Area Denial (A2/AD).

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 Ground Portfolio.

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

Work in this PE complements PE 0603119A (Ground Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Entry and Sustainment in Complex Contested Environments	-	2.756	0.913
Description: This effort develops strategic and tactical level planning tools for assessing engineering behavior of ground surfaces as it relates to battlefield maneuver to include factors affecting on-and-off-road vehicle mobility as well as aviation assembly areas; applies new technologies for data acquisition to engineering design factors to rapidly assess vehicle and terrain interaction.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL7 / *Power Projection in A2AD Environments Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Conduct experiments on engineering properties of ice and snow to investigate remote sensing technologies for off-road mobility in extreme environments; explore Light Detection and Ranging and photogrammetric data exploitation for characterizing lines of communication; will design and develop computational framework for rapid determination of road structural capacity. ***FY 2021 Plans:*** Will validate remote sensing data analysis algorithms for predicting off-road mobility in arctic regions; will design and develop methodology for rapid road and trail classification; will conduct computational experiments for analyzing ground vehicle impact on bound and unbound granular materials. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 a portion of the funding for this effort will continue in the Engineering for Battlespace Maneuver effort in this Project.			
Title: Engineering for Battlespace Maneuver ***Description:*** This effort develops the capability to rapidly repair and upgrade damaged infrastructure along mobility corridors and restaging areas to maintain and enhance freedom of maneuver achieving overmatch and tactical advantage in contested complex environments. ***FY 2021 Plans:*** Will design and develop techniques for rapid soil stabilization to support military ground vehicle maneuver; will conduct experiments to provide stand-off assessments of existing route characteristics; will develop algorithms to support engineer planning for route maintenance to prioritize maneuver corridors based on available engineer assets. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Work in this effort was previously conducted under the Entry and Sustainment in Complex Contested Environments effort in this Project.	-	-	1.000
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.010	-
Accomplishments/Planned Programs Subtotals	-	2.766	1.913

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL7 / *Power Projection in A2AD Environments Technology*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL9 / *Protection from Advanced Weapon Effects Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BL9: *Protection from Advanced Weapon Effects Technology*	-	0.000	4.403	3.957	-	3.957	7.393	4.346	5.332	5.332	0.000	30.763

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602784A Military Engineering Technology
* Project T40 Mobility/Weapons Effects Technology

A. Mission Description and Budget Item Justification

This Project develops structural hardening, high-performance computing capabilities, and force protection technologies to enhance survivability of personnel and critical assets. This project investigates and develops advanced materials for protection against blast, fragmentation, and penetration through physical experiments and modeling and simulation. Additionally, this project investigates, designs, and develops passive protection technologies and protective design criteria to mitigate attack from emerging advanced threats.

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 Ground Portfolio.

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

Work in this PE complements PE 0603119A (Ground Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Materials and Modeling for Force Protection	-	1.409	1.427
Description: This effort develops advanced composite and other protective materials and multi-scale modeling techniques to reduce material weight and increase resistance against blast and penetration threats; develops innovative virtual material design procedures and optimized manufacturing processes supported by computational modeling and simulation.			
FY 2020 Plans: Scale up optimized protective material systems including new composite materials for expeditionary protective systems and use multi-scale modeling to develop protective materials for structural hardening using foreign indigenous materials.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL9 / *Protection from Advanced Weapon Effects Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will develop multi-scale modeling approaches for materials of geological origin and composite material systems. Will conduct physical and computational experiments to investigate multiple force protection materials and components against relevant advanced weapon threats. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Defeat of Complex Attack ***Description:*** This effort develops passive protection structural hardening designs and solutions against emerging large-caliber advanced weapons; investigates and validates computational models for predicting residual protective capacity for multi-hit threat scenarios; and develops micro-mechanics-based models and material solutions matured by conducting high-rate experiments. ***FY 2020 Plans:*** Validate algorithm and design methodology for enhancing practical material solutions used in structural hardening and will develop and conduct high-rate and high-pressure experiments for micromechanical and continuum scale computational models. ***FY 2021 Plans:*** Will refine algorithms and design methods for structural hardening material solutions by conducting advanced high-rate and high-pressure dynamic experiments to improve computational models at the micro-mechanical and macro-continuum scales. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	2.969	2.530
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.025	-
Accomplishments/Planned Programs Subtotals	-	4.403	3.957

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BL9 / *Protection from Advanced Weapon Effects Technology*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BN8 / *Ground Technology Materials(CA)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BN8: *Ground Technology Materials(CA)*	-	0.000	108.700	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	108.700

Note

Congressional Interest Item funding provided for Ground Technology Materials.

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Ground Technology Materials.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Environmental Quality Enhanced Coatings ***FY 2020 Plans:*** Environmental Quality Enhanced Coatings	-	5.000
Congressional Add: Environmental Friendly Coatings Technology ***FY 2020 Plans:*** Environmental Friendly Coatings Technology	-	3.000
Congressional Add: Additive Manufacturing for Artificial Intelligence and Machine Learning ***FY 2020 Plans:*** Additive Manufacturing for Artificial Intelligence and Machine Learning	-	5.000
Congressional Add: Earthen Structures Soil Enhancement ***FY 2020 Plans:*** Earthen Structures Soil Enhancement	-	4.000
Congressional Add: M1 Abrams Tank Track System ***FY 2020 Plans:*** M1 Abrams Tank Track System	-	2.200
Congressional Add: High Performance Polymers ***FY 2020 Plans:*** High Performance Polymers	-	5.000
Congressional Add: Materials Manufacturing Processes ***FY 2020 Plans:*** Materials Manufacturing Processes	-	6.000
Congressional Add: Highly Durable Advanced Polymers for Lightweight Armor	-	8.000

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** BN8 / *Ground Technology Materials(CA)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
FY 2020 Plans: Highly Durable Advanced Polymers for Lightweight Armor		
Congressional Add: Cellulose Nanocomposite Research ***FY 2020 Plans:*** Cellulose Nanocomposite Research	-	5.000
Congressional Add: Countermine Program ***FY 2020 Plans:*** Countermine Program	-	5.000
Congressional Add: Materials Research ***FY 2020 Plans:*** Materials Research	-	17.500
Congressional Add: Additive Manufacturing and Materials Processing ***FY 2020 Plans:*** Additive Manufacturing and Materials Processing	-	15.000
Congressional Add: Cold Weather Military Research ***FY 2020 Plans:*** Cold Weather Military Research	-	3.000
Congressional Add: Cold Spray Technologies ***FY 2020 Plans:*** Cold Spray Technologies	-	15.000
Congressional Add: Center for Research in Extreme Batteries ***FY 2020 Plans:*** Center for Research in Extreme Batteries	-	10.000
Congressional Adds Subtotals	-	108.700

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CA9 / *Predictive Maintenance*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
CA9: *Predictive Maintenance*	-	0.000	0.000	2.604	-	2.604	3.709	4.802	5.715	5.829	0.000	22.659

Note

In Fiscal Year 2021 (FY21) this Project was realigned from:
Program Element (PE) 0602145A Next Generation Combat Vehicle Technology
* Project BF8 Artificial Intelligence & Machine Learning Tech

A. Mission Description and Budget Item Justification

This Project develops and characterizes artificial intelligence (AI) and machine learning (ML) tools and capabilities to intelligently predict and analyze maintenance status for emerging and legacy ground platforms; extracts maintenance data from existing databases, sensor data and inference of missing data via virtual simulations investigating maintenance concepts that employ AI data capture and integrate AI tools into enterprise resource planning for military ground vehicles. Research enables use of predictive maintenance to increase fleet operational readiness through reduced downtime by preventing critical failure during missions, maximizing availability to combatant commands.

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

Work in this Project supports the Army Science and Technology Ground Portfolio and the Joint Artificial Intelligence Center (JAIC)

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Predictive Maintenance	-	-	2.604
Description: This effort performs research on AI, deep learning, and predictive analytics to forecast major issues on platforms and enables services to respond to upcoming failures. Focus will be to identify component failure relationships to principal end items for prediction of critical failure prior to corrective maintenance and reactive supply chain requisitions. Research will increase efficiency, decrease fleet operating and sustainment costs for equipment platforms, and reduce the time and costs associated with repair part requisition, management and transportation.			
FY 2021 Plans: Will investigate and develop new capabilities of a standardized end-to-end pipeline for gathering data from maintenance sensors in ground platforms (both manned and unmanned); improve performance failure prediction models for critical components;			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602144A / *Ground Technology*	**Project (Number/Name)** CA9 / *Predictive Maintenance*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
develop engine health model to predict maintenance events; develop data analytics to categorize failures both off-line (in depot tear-downs) and to aid field maintainers. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This effort is realigned in FY21 from PE 0602145A (Next Generation Combat Vehicle Technology) / BF8 (Artificial Intelligence and Machine Learning Technology) to support Army modernization priorities.			
Accomplishments/Planned Programs Subtotals	-	-	2.604

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	0.000	263.547	217.565	2.000	219.565	237.850	236.099	253.416	278.222	0.000	1,488.699
BF1: *Autonomous Ground Resupply Tech*	-	0.000	11.301	11.018	-	11.018	0.000	0.000	0.000	0.000	0.000	22.319
BF3: *Combat Vehicle Robotics Tech*	-	0.000	11.658	9.182	-	9.182	17.456	12.914	8.728	7.473	0.000	67.411
BF6: *Crew Augmentation and Optimization Tech*	-	0.000	23.027	19.022	-	19.022	21.765	22.263	22.693	20.626	0.000	129.396
BF8: *Artificial Intelligence & Machine Learning Tech*	-	0.000	18.651	19.894	2.000	21.894	28.578	40.888	64.387	78.379	0.000	252.777
BF9: *Sensors for Autonomous Operations and Surv Tech*	-	0.000	15.283	38.154	-	38.154	38.927	26.697	26.996	26.997	0.000	173.054
BG2: *Modeling and Simulation for MUMT Technology*	-	0.000	3.966	3.397	-	3.397	11.054	11.277	7.846	7.846	0.000	45.386
BG6: *Advanced Concepts for Active Defense Technology*	-	0.000	53.469	45.983	-	45.983	43.081	47.203	47.651	49.626	0.000	287.013
BG8: *Obscuration Technology*	-	0.000	4.070	2.620	-	2.620	2.675	2.729	2.758	2.786	0.000	17.638
BH2: *C4ISR Modular Autonomy Technology*	-	0.000	4.874	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.874
BH5: *Platform Electrification and Mobility Tech*	-	0.000	10.024	21.275	-	21.275	19.989	16.221	13.580	18.689	0.000	99.778
BH7: *Enhanced VETRONICS Technology*	-	0.000	3.603	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.603
BH9: *Protection for Autonomous Systems Tech*	-	0.000	2.548	1.499	-	1.499	1.499	1.998	2.098	2.098	0.000	11.740
BI2: *Sensor Protection Technology*	-	0.000	10.584	10.340	-	10.340	10.599	10.822	10.952	10.953	0.000	64.250
BI4: *Materials Application and Integration Tech*	-	0.000	8.313	7.689	-	7.689	7.819	7.972	8.057	8.058	0.000	47.908

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army												Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*							
BI6: *All-Electric Combat Powertrain Technology**	-	0.000	0.000	0.000	-	0.000	0.000	2.498	5.595	9.992	0.000	18.085
BI9: *Vehicle System Security Technology*	-	0.000	2.951	2.777	-	2.777	2.827	2.253	2.125	3.572	0.000	16.505
BJ2: *Tactical and Navigation Lasers Sensors Technology*	-	0.000	4.990	5.453	-	5.453	5.562	5.673	5.737	5.794	0.000	33.209
BJ3: *Hydrogen Based Combat System Technology*	-	0.000	7.127	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	7.127
BJ7: *Detection of Explosive Hazards Technology*	-	0.000	11.882	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	11.882
BJ9: *Autonomous Mobility Tech*	-	0.000	3.060	2.498	-	2.498	3.996	0.000	0.000	0.000	0.000	9.554
BK2: *Virtual Prototyping Technology*	-	0.000	5.426	8.609	-	8.609	8.482	8.608	8.292	8.316	0.000	47.733
BK3: *Next Gen Intelligent Fire Control (NG-IFC) Tech*	-	0.000	1.050	4.196	-	4.196	0.999	0.999	0.000	0.000	0.000	7.244
BK5: *Adv Direct In-Direct Armament Sys (ADIDAS) Tech*	-	0.000	1.190	3.959	-	3.959	12.542	15.084	15.921	17.017	0.000	65.713
BP5: *Ground Vehicle Technology (CA)*	-	0.000	44.500	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	44.500

*This project's R-2a exhibit has been suppressed due to funding not beginning until after FY 2021

Note

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
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*

* 0602716A Human Factors Engineering Technology
* 0602783A Computer and Software Technology
* 0602784A Military Engineering Technology

A. Mission Description and Budget Item Justification

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

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

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

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

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

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

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	0.000	219.047	230.179	-	230.179
Current President's Budget	0.000	263.547	217.565	2.000	219.565
Total Adjustments	0.000	44.500	-12.614	2.000	-10.614
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	44.500			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	-12.614	2.000	-10.614

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	**Date:** February 2020
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*

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2019**	**FY 2020**
Project: BP5: *Ground Vehicle Technology (CA)*		
Congressional Add: *Prototyping Energy Smart Autonomous Ground Systems*	-	10.000
Congressional Add: *Highly Electrified Vehicles*	-	5.000
Congressional Add: *Additive Metals Manufacturing*	-	3.000
Congressional Add: *RPG and IED Protection*	-	3.000
Congressional Add: *Modeling and Simulation*	-	3.000
Congressional Add: *Structural Thermoplastics*	-	3.000
Congressional Add: *Advanced Materials Development for Survivability*	-	10.000
Congressional Add: *Autonomous Vehicle Mobility*	-	7.500
Congressional Add Subtotals for Project: BP5	-	44.500
Congressional Add Totals for all Projects	-	44.500

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BF1: *Autonomous Ground Resupply Tech*	-	0.000	11.301	11.018	-	11.018	0.000	0.000	0.000	0.000	0.000	22.319

Note

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

A. Mission Description and Budget Item Justification

Autonomous Ground Resupply (AGR) will design and develop modeling and simulation tools and advanced software behaviors to inform future ground supply distribution system requirements across multiple levels of strategic and tactical sustainment operations. The modeling and simulation software tools will be incorporated into a suite of products designed to support every phase of AGR and used to develop and refine AGR concepts, test vehicle designs, evaluate design changes, determine technology performance, and predict outcomes in a wide variety of terrain, weather, and environmental conditions. The effort will utilize the modeling and simulation software tools to design, develop and mature software; and conduct experiments to increase future autonomy capabilities. Increased capabilities will transition to PE 0603462 (Next Generation Combat Vehicle Advanced Technology) to be integrated into a Soldier evaluation to obtain user feedback and inform and transition to the Leader/Follower Program of Record. The architecture and safety work under this Project also lays the groundwork for Army Modernization Priority Next Generation Combat Vehicle (NGCV).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering Priority focus areas and the Army Modernization Strategy. Work in this Project supports the Army Modernization Priority NGCV.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: Software for Autonomous Systems	-	9.544	10.023	-	10.023

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BF1 / *Autonomous Ground Resupply Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Description: Develop and implement advanced system behaviors to address leader follower capabilities, including algorithms for dynamic route planning, world modeling that feature system cues and collaboration to minimize the cognitive load placed on soldiers managing groups of unmanned systems. ***FY 2020 Plans:*** Will develop advanced software behaviors to address Leader Follower capabilities; including the integration of trailers (forward and reverse), convoy reverse capabilities, and convoy formations. Will investigate and develop new advanced convoy behaviors to enable autonomous convoy operations. Will develop algorithms for dynamic route planning and world modeling that feature system cues and collaboration to minimize the cognitive load placed on soldiers managing groups of unmanned systems. ***FY 2021 Base Plans:*** Will continue to develop advanced software behaviors and algorithms for integration into the fail-safe autonomous ground vehicle architecture and conduct field testing to validate increased robotic capabilities, which include: the integration of trailers (forward and reverse), convoy reverse capabilities, convoy formations, dynamic route planning and world terrain modeling to minimize the cognitive load placed on Soldiers managing groups of unmanned systems. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.					
Title: Autonomous System Modeling and Simulations ***Description:*** This effort matures a real-time, hardware-in-the-loop simulation environment for rapid autonomous system design and development and for robust autonomy algorithm development; investigates novel analyses methods for Modeling and Simulation enhanced demonstrations of autonomous ground vehicles to include adverse environmental conditions. ***FY 2020 Plans:*** Will mature simulation environments and will improve algorithms to predict autonomous vehicle system performance in adverse environmental conditions; will provide improved analytical tools to investigate the benefits of autonomous ground resupply and optimize sensor configurations for autonomous maneuver. ***FY 2020 to FY 2021 Increase/Decrease Statement:***	-	1.243	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BF1 / *Autonomous Ground Resupply Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
In FY21 work in this effort is realigned to the Simulation Tools for AGR effort in this Project.					
Title: Simulation Tools for AGR ***Description:*** This effort designs and develops real-time and high-fidelity, hardware and software-in-the-loop simulators capable of rapid design and assessment of ground vehicle autonomous behaviors through integration with autonomy solutions. ***FY 2021 Base Plans:*** Will investigate simulation design, development, and performance as well as develop tools to explore autonomous system performance; develop simulation-enabled analysis methods for Autonomous Ground Resupply capstone events; and investigate integration of additional sensors and algorithms into simulation tools. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 work in this effort was realigned from the Autonomous System Modeling and Simulations effort in this Project.	-	-	0.995	-	0.995
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.514	-	-	-
Accomplishments/Planned Programs Subtotals	-	11.301	11.018	-	11.018

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BF3: *Combat Vehicle Robotics Tech*	-	0.000	11.658	9.182	-	9.182	17.456	12.914	8.728	7.473	0.000	67.411

Note

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

A. Mission Description and Budget Item Justification

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

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy. Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle (NGCV).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: Autonomous Behaviors and Perception	-	5.054	3.555	-	3.555
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 2020 Plans: Will develop the semi-autonomous on-road and off-road mobility technology to focus on the rules of the road and begin to establish behaviors for tactical formations and operationally relevant speeds. Will develop algorithms and capabilities for obstacle detection/avoidance, mounted/dismounted following, dynamic route planning, manned/unmanned teaming, and individual/coordinated learning and environmental modeling.					
FY 2021 Base Plans:					

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Will develop the dynamic obstacle detection and avoidance capability and integrate with advanced off-road autonomous navigation and conduct experiments for defined missions with tactical formations at operationally relevant speeds. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding in this effort is realigned to PE 0603462A (Next Generation Combat Vehicle Technology), Project BF4 (Combat Vehicle Robotics Advanced Technology) to better reflect the work being performed.					
Title: Autonomous Architecture ***Description:*** This effort contributes to the NGCV RAS to implement an open autonomous architecture for an inclusive military library of behaviors that are non-proprietary and in a modular format to allow for design and development of payloads across the enterprise. This effort builds upon architecture activities under the autonomous ground resupply activity, further expanding the Autonomous Ground Vehicle Robotics Architecture for increased complexity of military maneuvers as well as the Robotic Operating Systems ? Military (ROS-M) framework. ***FY 2020 Plans:*** Will develop a set of guidelines to enable the robotics community to fulfill the Army?s NGCV RAS commonality objectives with an affordable means to deliver advanced capability to the Warfighter by utilizing architectural best practices and standards. Will develop military repositories and an ecosystem for the sharing of robotic vehicle software to help reduce the cost of developing software for autonomous robotic platforms and increase the overall reliability, security, maturity, and interoperability of the software. ***FY 2021 Base Plans:*** Will continue to develop and establish ROS-M framework of reusable and adaptable software developed in collaboration with other Government Agencies and industry to align the robotics community to a common architecture. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	1.973	1.680	-	1.680
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	-	4.101	3.947	-	3.947

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
the Soldier while maintaining real-time unmanned system status/activity, overall mission effectiveness, and predictive capability of the system's intended activity. ***FY 2020 Plans:*** Will design and develop a multi-vehicle asset control approach that will have the capability to interface with multiple robotic assets on an interface either at a command mission planning level or directly to each asset that will allow for multi-user connection with different levels of authority. Will investigate multi-modal communications interface techniques for soldier interaction that will have the capability to interface with a robotic asset with multiple modes of communication either separately or all combined into one multi-modal mission command system. ***FY 2021 Base Plans:*** Will mature the operator-directed voice recognition for command and control of the robotic ground system maneuver. Will assess the performance of how naturally the robotic system interacts with human operators through experiments or experimentation to improve manned-unmanned system teaming. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.					
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.530	-	-	-
Accomplishments/Planned Programs Subtotals	-	11.658	9.182	-	9.182

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army												Date: February 2020
Appropriation/Budget Activity 2040 / 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 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**	**FY 2022**	**FY 2023**	**FY 2024**	**FY 2025**	**Cost To Complete**	**Total Cost**
BF6: *Crew Augmentation and Optimization Tech*	-	0.000	23.027	19.022	-	19.022	21.765	22.263	22.693	20.626	0.000	129.396

Note

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

A. Mission Description and Budget Item Justification

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

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy. Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle (NCVG).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**
Title: Crew Station / Closed Hatch Operations	-	3.856	-	-	-
Description: This effort focuses on crew size reduction and crew stations tailored to mission and soldier needs through the utilization of emerging human-interaction technologies, automations, machine intelligence and the					

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
provision of cohesive domain personalization to permit soldiers to achieve leap-ahead performance beyond today's constrained ground vehicle environment. ***FY 2020 Plans:*** Will develop baseline crew station technology for a seven soldier vehicle in both Manned Fighting Vehicle and Infantry Carrier Vehicle configurations to optimize task effectiveness, investigate and adapt helmet mounted display functionality for ground vehicle applications and incorporate rudimentary driving automations to validate utility of artificial intelligence as a soldier task enabler. Will assess motion effects on crew station utilizing motion based simulation. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 funding in this effort was realigned to the Crew & Robotic Mission with Agent Technology and Platoon Teaming Capability efforts in this Project to better describe the work being performed.					
Title: Crew Understanding Agents ***Description:*** This effort focuses on increasing the crew's comprehension of physical and virtual intelligent agent actions, intentions, goals, and general reasoning in order to increase the effectiveness of human-agent teaming. The effort will increase soldiers situational awareness and team resilience as well as inform effective use of intelligent assets. ***FY 2020 Plans:*** Will create first of its kind machine-learning based Learning - Warfighter Machine Interfaces (L-WMI) technology to enhance crew?s ability to plan missions. Apply theoretical approaches to increase a crew's comprehension of unmanned vehicle actions, intentions, goals, and general reasoning to operationally relevant, multi-tasking, team crew software-in-the-loop environments; integrate with L-WMI technology to improve planning based on crew?s improved comprehension of crew interactions with unmanned vehicles. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort is realigned to the Enabling Soldier-AI Technology Adaptation, Crew Capability Enhancement and Human Augmentation for Collective Training efforts in this Project.	-	7.847	-	-	-
Title: Agents Understanding Crew ***Description:*** This effort focuses on increasing intelligent agent ability to understand crew actions, intentions, goals, and general reasoning in order to increase the effectiveness of human-intelligent agent teaming. The	-	5.924	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
effort will enable effective adaptation by intelligent agents, increase appropriateness of intelligent agent actions, increase manned/unmanned team resilience, and is critical for intelligent approaches to dynamic team tasking. ***FY 2020 Plans:*** Will generate and enhance real-time algorithms to enhance ability of intelligent agents to understand vehicle crew behaviors, states, and intentions; integrate with L-WMI technology to improve planning based on crew?s ability to predict crew dynamics and capability changes over mission. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort is realigned to the tasks Dynamic Soldier-AI Team Resource Allocation, Soldier Cognition-Centric Interface Technologies and Characterize Soldier-Adaptive AI Interactions efforts in this Project.					
Title: Joint Human-Agent Teamwork ***Description:*** Will design and develop Commander?s interface to enable dynamic task reassignment across crew members and unmanned platforms to provide capability of crew members to manually share critical tasks as capabilities and mission needs change; Will investigate novel algorithms and communication protocols for developing, maintaining and sharing situational awareness across a distributed heterogeneous team to enable improved decision making and rapid team reconfiguration; Will develop novel machine learning approaches to enable Soldiers to rapidly train artificial intelligence systems on simulated and physical platforms ***FY 2020 Plans:*** Will create novel technologies to identify gaps in common situational awareness between and among vehicle crew and intelligent agents. Perform soldier-based assessment of simulated technology concepts and soldier-focused experimentation. Assessment and experimentation will be performed in an operationally relevant, crew teaming environment. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort is realigned to the Soldier?AI Team Mission Planning for Dynamic Complex Environments and Human Augmentation for Collective Training efforts in this Project.	-	4.354	-	-	-
Title: Crew & Robotic Mission with Agent Technology ***Description:*** This effort focuses on the design, development and validation of hardware and software for establishing crew to robotic mission operator interactions to address full vehicle performance. Included are simulation tools and hardware for Soldier-in-the-loop testing including the Learning Warfighter Machine Interface (L-WMI), a seven-Soldier vehicle crew configuration command vehicle simulator; personalization of crew and	-	-	1.498	-	1.498

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
robotic operator configurations to permit reconfiguration for role, mission requirements and Soldier monitoring; optimization of vehicle crew interactions to permit sharing, reallocation and management of tasks, as well as situational awareness and data management. ***FY 2021 Base Plans:*** Will validate enhancements to the crew?s ability to plan missions and optimization of crew?s comprehension of crew interactions with unmanned systems by integrating the L-WMI onto a motion-based simulation platform. Will validate behavioral and communications-based Soldier state assessment approaches in an operationally-relevant, motion-based simulation environment. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort is realigned from the Crew Station / Closed Hatch Operations efforts in this Project.					
Title: Crew Capability Enhancement ***Description:*** This effort focuses on the dynamic interaction of Soldiers, responsible for both manned and unmanned ground vehicles, working together within a platoon formation. Research focuses on the simultaneous use of multiple technologies by Soldiers including transparent multi-modal user interfaces, commander?s tools for maintaining and enhancing situation awareness, decision aids for enabling dynamic resource allocation and orchestration, and tools to interact with and adapt vehicle based autonomy. Products will include artificial intelligence algorithms, information display technologies, and team-centric design principles. ***FY 2021 Base Plans:*** Will develop a concept for a Commander?s interface to demonstrate dynamic task reassignment across crew to enable crewmembers to manually share critical tasks as capabilities and mission needs change; investigate novel algorithms and communication protocols for developing, maintaining, and sharing situational awareness across a distributed Soldier-Artificial Intelligence team to enable improved decision making and rapid team reconfiguration. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort is realigned from the Crew Understanding Agents effort in this Project.	-	-	2.877	-	2.877
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,	-	-	2.443	-	2.443

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
high-resolution characterization of joint Soldier and Artificial Intelligence (AI) enabled intelligent-agent adaption in complex environments. ***FY 2021 Base Plans:*** Will create algorithms for characterizing crew behavior and adaptations; create algorithms for characterizing AI behavior and adaptations; develop initial advanced techniques for integrating subject matter expertise with machine learning approaches for characterizing intelligent-agent behaviors and adaptations. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort is realigned from the Agents Understanding Crew effort in this Project.					
Title: Human Augmentation for Collective Training ***Description:*** This effort investigates assessment techniques of crew performance to inform the development of individual and collective training for military vehicles. Assessment techniques will be applicable across a wide-variety of vehicle platforms, training tasks and vehicle crew roles. This effort will support training and increased force readiness of vehicle crews in complex environments by developing accurate and efficient performance assessment techniques evaluated in complex Operational Environments (OE) enabled by the latest advances in simulation and training technology. ***FY 2021 Base Plans:*** Will design and conduct laboratory experiments to investigate training and visual display concepts that improve coordination and communication in manned-unmanned teaming operations in experimental crew station environments. Will investigate and validate training methods using reconfigurable unmanned system command vehicle representative training system testbeds to support improved individual and crew adaptation to dynamic task-changing events and inform training system design for embedded and non-embedded training capabilities. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort is realigned from the Crew Understanding Agents and Joint Human-Agent Teamwork efforts in this Project.	-	-	2.254	-	2.254
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	-	-	1.339	-	1.339

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
evaluate these capabilities in application of intelligent task management and data-driven prediction of crew to support changing mission goals. ***FY 2021 Base Plans:*** Will validate interface for manual, pre-planned, cross-vehicle task reassignments by the team leader in order to enhance team performance based on crew status and mission objectives. Will conduct experiment utilizing limited semi-autonomous maneuver for unstructured off-road operations in a motion-based simulation environment. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 work in this effort is realigned from the Crew Station / Closed Hatch Operations effort in this Project.					
Title: Soldier?AI Team Mission Planning for Dynamic Complex Environments ***Description:*** Planning in multi-domain operations environments is complex and has increased temporal and spatial sensitivities for Soldiers to integrate with AI systems to plan missions. This effort provides the fundamental concepts and technologies to enable Soldiers and AI systems to team together to plan for multi-domain operations from a ground vehicle perspective. This effort focuses on planning enablers to maximize manned-unmanned team performance across squads and platoons and includes crew station-based emerging technologies in the areas of human- interaction with AI technologies and human-guided machine intelligence. Approaches focus on modeling both Soldier and AI capabilities and their limitations as a function of the mission environment and mission requirements, and applying those models to forming mission plans. ***FY 2021 Base Plans:*** Will conduct experiments to augment Learning Warfighter-Machine Interface capabilities to include enhanced mission planning capabilities that account for the relationship between terrain and environmental features as well as crew performance across multiple manned and unmanned ground vehicles. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort is realigned from the Joint Human-Agent Teamwork effort in this Project.	-	-	1.251	-	1.251
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	-	-	2.434	-	2.434

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Soldiers, platforms, and platform sub-system capabilities with the focus to ensure that future AI and automation capabilities are focused on the circumstances and conditions where they are most likely to be successful, and to ensure that the resources of the Soldier-AI team are focused appropriately to ensure mission success. ***FY 2021 Base Plans:*** Will design and develop Commander?s interface to enable dynamic task reassignment across crew to provide capability of crew members to manually share critical tasks as team capabilities and mission needs change; investigate novel algorithms and communication protocols for developing, maintaining, and sharing situational awareness across a distributed heterogeneous team to enable improved decision making and rapid team reconfiguration. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort is realigned from the Agents Understanding Crew effort in this Project.					
Title: Soldier Cognition-Centric Interface Technologies ***Description:*** This effort creates cognitive-centric displays that ensure Soldiers are focused on aspects of situational awareness, mobility, target engagements, and communications that are critical to mission performance as future crew stations and displays provide vast amounts of multi-domain information that has the potential to distract, overwhelm, and mislead Soldiers. This effort ensures that our systems do not capture and misdirect Soldier attention and/or cognition, maximizing the utility of AI systems to the Soldier. This effort enables Soldiers to better understand the actions, goals, intents, and general reasoning of the AI systems to ensure they are effectively used, but not inappropriately relied upon. ***FY 2021 Base Plans:*** Will investigate novel approaches to characterize overall team cohesion in a distributed Soldier-AI team; and conduct experiments to examine approaches for quantifying a crew?s trust in AI-enabled autonomous systems. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort is realigned from the Agents Understanding Crew effort in this Project.	-	-	1.598	-	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	-	-	3.328	-	3.328

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
the ability of Soldier-AI teams to rapidly adapt to adversarial actions, new technologies, environmental changes, and mission requirements; 2) decreasing the data requirements to train and adapt AI-enabled systems; 3) increasing Soldier trust and use of technology; and 4) ensuring ethical decisions by using Soldiers to guide the actions and in-field adaptations of Soldier-AI team behaviors. ***FY 2021 Base Plans:*** Will leverage data from multiple sensor systems and sensing approaches to improve robustness of real-time algorithms for understanding crew status, actions, intentions, and goals; investigate the ability for using information regarding crew behavior, physiology and interaction with intelligent agents to inform the development of novel approaches for assessing effectiveness of Soldier-AI teams; develop novel machine learning approaches to enable Soldiers to rapidly train AI systems on simulated and physical platforms. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort is realigned from the task Crew Understanding Agents effort in this Project.					
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	1.046	-	-	-
Accomplishments/Planned Programs Subtotals	-	23.027	19.022	-	19.022

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BF8: *Artificial Intelligence & Machine Learning Tech*	-	0.000	18.651	19.894	2.000	21.894	28.578	40.888	64.387	78.379	0.000	252.777

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: Advanced Distributed Power for Autonomous Platforms	-	1.395	-	-	-
Description: The effort investigates power distribution and conversion technologies to provide compact, efficient, and high power capabilities for electrical and electro-mechanical loads supporting both mobile and					

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
stationary platforms. High voltage and intelligent control methods will be coupled with the ongoing research in autonomy technologies to provide advanced performance enhancements in mobility and capabilities for these platforms. Research on innovative electric machines covering both electrical generation and motor technologies will focus on providing efficient, power dense, fault tolerant generation and mobility capabilities. Research addresses current and future Army-unique power delivery challenges in compact autonomous air and ground platforms and provides increased mission effectiveness with reduced cognitive burden. ***FY 2020 Plans:*** Will investigate optimization methods and analytical techniques to provide mission effective energy management at the tactical unit level; will investigate control methods and circuitry that enable intelligent power control at the module and component levels within the power distribution system; will develop power-dense direct current (DC)-DC distribution hardware and software that autonomously manages power conversion and distribution. Methods to be considered include embedded sensors, machine learning, and energy flow analysis. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This effort is realigned in FY21 to PE 0622145A (Next Generation Combat Vehicle Technology) / BH5 (Platform Electrification and Mobility Tech) to better align the work being performed.					
Title: Scalable, Adaptive, and Resilient Autonomous Systems ***Description:*** This effort develops and matures emerging research in Artificial Intelligence/Machine Learning (AI/ML), human agent teaming, scalable and collaborative behaviors, embodied and embedded intelligence, and autonomous operations for next generation Army platforms in dynamic Army relevant environments, architectures, and missions. Specific focus will be on application of AI/ML to autonomous systems and human-intelligent agent teaming; scalable and collaborative behaviors in support of heterogeneous air and ground manned-unmanned teaming (MUM-T) operations; methods for embodied and embedded intelligence for increased understanding, manipulation, and reflexive maneuver through and interaction with dynamic environments; techniques for improved perception, decision making, and adaptive behaviors in contested environments for MUM-T; and new methods for testing and evaluating emerging technologies for intelligent and autonomous systems under Army relevant constraints and environments and in Army relevant architectures. ***FY 2020 Plans:*** Will develop architectures, algorithms, data sharing approaches, and control methodologies to enable scalable numbers of heterogeneous, air and ground intelligent systems to collaboratively perform (autonomous and semi-autonomous) maneuver foroperations. Will investigate methods, metrics, and tools to facilitate, simulate, and	-	7.194	4.505	-	4.505

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
enable testing and evaluation of emerging approaches for individual and collaborative intelligent systems in Army relevant constraints and environments. ***FY 2021 Base Plans:*** Will investigate and develop methods for metric- and semantic-based world models as well as small unmanned aerial system and unmanned ground system coordinated maneuver; will validate AI/ML methods to enable tactically-informed behaviors and maneuver of autonomous systems under Army-relevant constraints and environments. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding is realigned in FY21 to Predictive Maintenance Project in PE 0622144A (Ground Technology) to represent application of AI/ML technology.					
Title: Context-Based Information Dynamics ***Description:*** This effort investigates techniques that integrate on-board and external information sources, and it applies ML analytic approaches to support automated intelligence analysis and decision making. The goal is to enable tactical agents to cooperatively share relevant and timely tactical information within a distributed environment. ***FY 2020 Plans:*** Will investigate intelligent approaches that are resilient to adversarial threats and to continuous learning threats and maximize soldier and agent situational awareness; investigate methods and models for complex or social event processing, with compact representations, efficient pattern evaluation, and mission-centric focus to accelerate reasoning and decision making; study self-aware characteristics of intelligent or non-stationary agents. ***FY 2021 Base Plans:*** Will investigate methods for using machine learning approaches to provide information mediation and transformation to identify approaches that address tactical dynamics and challenges of distributed intelligent command and control system interoperation. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Adjustment to economic assumptions.	-	2.248	2.149	-	2.149
Title: Heterogeneous Computing and Computational Sciences	-	1.620	1.508	-	1.508

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Description: This effort researches and develops software algorithms to allow information processing across different computing hardware platforms. The goal of this research is to provide high performance computing and processing capabilities to the Soldier on the battlefield. ***FY 2020 Plans:*** Will develop resource constraints-aware heterogeneous adaptive computing abstractions, optimizations, and algorithms. Will develop AI/ML algorithms and models to build local decision making framework to enable intelligent computational off-loading and distributed computing under resource constrained and contested environments. Preliminary design and construction of an adaptive heterogeneous computing testbed that combines processors with varying capabilities and size, weight and power footprints to allow for exploration and optimization of Army tactical application processing. ***FY 2021 Base Plans:*** Will continue to develop adaptive computation algorithms for AI/ML processing at resource-constrained tactical edge for NGCV platforms, and to build local decision making framework to enable intelligent computational off-loading and distributed computing under resource constrained and contested environments. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Adjustment to economic assumptions.					
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 2020 Plans:*** Will investigate novel on-line ML approaches that enable high-speed (similar to human speed) mobility of autonomous ground vehicles in complex environments on which the vehicle has not been previously trained	-	3.993	3.926	-	3.926

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
and by teaming with the soldier to accelerate algorithm training and provide dynamically changing goals for the autonomous ground vehicle. ***FY 2021 Base Plans:*** Will investigate novel machine learning approaches that allow trained models to be transferred between autonomous ground vehicles operating in similar domains; investigate algorithms that allow learned models to be developed from synthetic or offline training data; develop algorithms that allow autonomous ground vehicles to use semantic representations of the environment to navigate in complex environments; extend surrogate models for use of physical self-awareness for autonomous flight of unmanned aerial systems (UASs) to incorporate differing, static weather conditions, including pressure, wind-speed, and direction incorporating uncertainty in weather conditions; investigate the use of cyber agility and deception algorithms and methodologies as well as additional evasion defensive algorithms against Adversarial Machine Learning (AML) techniques in order to make tactical and enterprise systems resistant to attacks on their cyber defenses that rely on ML. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Adjustment to economic assumptions.					
Title: Ground Robotic Vehicle Mobility & Propulsion Technology ***Description:*** Applied research in ground robotic vehicle mobility and propulsion technologies to enhance intelligent vehicle performance (speed, acceleration, mobility, maneuverability, adaptability, etc.) and enable Army robotic platform maneuverability in complex terrain and environments. ***FY 2020 Plans:*** Will establish a novel AI/ML algorithm framework to improve vehicle maneuver performance in complex terrains, environments, and damage conditions. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort is realigned to the Intelligence for High Operational Tempo Maneuver effort within this Project.	-	1.354	-	-	-
Title: Intelligence for High Operational Tempo Maneuver ***Description:*** Applied research on intelligence for cognitive learning and control architectures to enable efficient and full use of embodied physical capabilities and create the machine intelligence required of autonomous systems to understand physical limitations. Investigates the means through which robotic physical performance attributes (e.g. speed, agility) will be coupled with artificial intelligence to enable resilient maneuver in high operational tempo missions in complex environments.	-	-	1.237	-	1.237

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
FY 2021 Base Plans: Will investigate efficient algorithms that respond quicker to increase maneuver speed, agility, and adaptability of autonomous systems over complex terrain. Will establish cognitive and control architectures that enable closed-loop self-aware and resilient tactical teaming behaviors at high operational tempos. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort is realigned from the Ground Robotic Vehicle Mobility & Propulsion Technology effort within this Project.					
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 Next Generation Combat Vehicle (NGCV). ***FY 2021 Base Plans:*** Will investigate novel algorithms for autonomous off-road navigation behaviors in complex environments at more operationally relevant speeds. Approaches will include learning from Soldier experimentation events to enable more tactically relevant behaviors with improved resiliency over current approaches. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This work is realigned in FY21 from PE 0602145A (Next Generation Combat Vehicle Technology) / BF6 (Crew Augmentation and Optimization Tech), BJ3 (Hydrogen Based Combat System Technology), and BI2 Sensor Protection Technology.	-	-	3.368	-	3.368
Title: Operational Assessment of Artificial Intelligence Developmental Systems ***Description:*** This effort supports the Combatant Commander's needs by performing operational assessments of AI-intense developmental weapon systems. ***FY 2021 Base Plans:*** None ***FY 2021 OCO Plans:*** Will begin an operational assessment of Artificial Intelligence developmental systems in support of a Combatant Commander identified need. ***FY 2020 to FY 2021 Increase/Decrease Statement:***	-	-	0.000	2.000	2.000

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
This effort is realigned from support to the Combatant Commanders.					
Title: Army Universities and Technical Alliances Collaboration ***Description:*** This effort conducts research leading to potential emerging technology development in areas of strategic importance to the Army in AI/ML and Robotics by bringing competitively selected Universities with research teams into Technical Alliances. The Technical Alliance collaborations consist of large collaborative hubs focused on developing and transitioning research in Army critical areas. Technical Alliances will be used to exploit opportunities to advance new capabilities through a sustained long- term multidisciplinary research effort. The primary focus of the Technical Alliances is expanding the frontiers of knowledge in research areas where the Army has enduring needs, and integrates state-of-the-art research programs at academic institutions to increase the supply of scientists and engineers to advance and optimize research within Army laboratories. ***FY 2021 Base Plans:*** Will investigate and research technologies for ground vehicles focusing on autonomy, AI/ML and robotics. Will research geospatially-enabled, autonomy-related machine learning technologies, advanced teaming, and navigation/routing necessary for the Ground Portfolio, NGCV and the Army Modernization Priorities. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding for this effort is realigned in FY21 to support Army Modernization priority efforts.	-	-	3.201	-	3.201
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.847	-	-	-
Accomplishments/Planned Programs Subtotals	-	18.651	19.894	2.000	21.894

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BF9: *Sensors for Autonomous Operations and Surv Tech*	-	0.000	15.283	38.154	-	38.154	38.927	26.697	26.996	26.997	0.000	173.054

Note

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

A. Mission Description and Budget Item Justification

This Project designs, and develops modular and adaptive sensor components, algorithms and machine learning/artificial intelligence tools which provide improved manned and unmanned ground vehicle situational understanding and enable aided target recognition (AiTR) and autonomous navigation in all environments.

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

Work in this Project supports the Army Next Generation Combat Vehicle (NGCV), Soldier Lethality (SL), and Future Vertical Lift (FVL) Modernization priorities.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: Sensors for Autonomous Operations and Survivability	-	14.589	-	-	-
Description: This effort will deliver sensor component technologies which greatly improve current and future uncooled thermal sensor performance through novel materials, new pixel designs and enhanced image processing, compression, and analysis capabilities. Research into novel multi-function digital read-out integrated circuits and other sensor components will provide embedded on-chip, non- uniformity correction, dynamic motion compensation, on-chip stabilization of infrared imagery and data compression with a significant reduction in data transmission requirements, greatly increased sensitivity of low size, weight, power and cost thermal sensors, and imaging capabilities through natural and manmade obscurants. This effort will research and develop threat cueing algorithms for unmanned aerial sensor borne electro-optic/infrared and ground penetrating radar sensors, and for ground vehicle based 360 degree sensors. This effort will investigate, develop and validate target detection and recognition algorithms with low false alarms rates and high probability of detection while on-					

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
the-move. These components will enable sensor systems to provide vehicle borne and dismounted soldier situational understanding in all environments and improve lethality by reducing decision making timelines. ***FY 2020 Plans:*** Will develop on-chip non-uniformity correction to enable on-chip calibration pre-processing. Will mature digital read out integrated circuits with on-chip compression, enabling high resolution imaging within bandwidth constricted environments. Will design and develop dynamic on-chip compression of thermal imagery to allow for 10x reduction in data rate. Will investigate novel pixel designs using advanced Micro Electro-Mechanical Systems with low thermal mass and high thermal isolation to increase sensitivity. Will mature fabrication techniques and pixel design to reduce thermal mass to enable the read-out integrated circuit to read entire focal plane array (FPA) at once (snapshot) and enable increased frame rate. Will validate novel high sensitivity uncooled longwave infrared FPAs for low size, weight, power and cost applications and to address 360-degree situational awareness requirements. Will design and develop compact high resolution thermal imaging sensors with three-dimensional imaging algorithms to enable compact navigation and threat detection capabilities. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This effort is realigned in FY21 to the Advanced Sensors with Embedded Processing, Multi-Mission Payload, and Automated Threat Cueing efforts in this same Project.					
Title: Advanced Sensors with Embedded Processing ***Description:*** Designs and develops advanced, automated multi-spectral and multi-function sensor components, and image processing techniques with improved performance in all environments and against all threats to include low-contrast targets in camouflage or in degraded conditions to enable combined arms maneuvers in complex environments for NGCV via manned, optionally manned, and robotic platform applications. ***FY 2021 Base Plans:*** Will validate Digital Readout Integrated Circuit (DROICs) with high dynamic range and on-chip compression to enable high resolution imaging within bandwidth constricted environments. Will mature on-chip non-uniformity correction for electro-optical / infrared (EO/IR) sensor components. Will mature and demonstrate dynamic on-chip compression of thermal imagery to allow for up to 10x reduction in data rate. Will begin development of pixel designs using advanced Micro-Electro Mechanical System (MEMS) to increase sensitivity. Will mature compact high resolution uncooled thermal imaging sensors with integrated three-dimensional imaging algorithms to enable compact navigation and threat detection capabilities. Will investigate exploitable scene features and target signatures throughout visible to long wave infrared portions of the spectrum to aid in robust threat	-	-	26.495	-	26.495

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
detection through experiments during various times-of-day/night, sky irradiance, targets and backgrounds. Will investigate the environmental parameters and target properties governing target detectability by EO/IR sensors operating at differing wavelengths to identify optimal sensor configurations. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 funding from the Sensors for Autonomous Operations and Survivability effort is realigned to the Advanced Sensors with Embedded Processing effort in this Project as well as being increased to support Army Modernization Priorities.					
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 2021 Base Plans:*** Will investigate and design unmanned aerial system (UAS) mountable polarized EO/IR sensors. Will conduct experiments co-registering EO/IR, and other modalities to determine design impact to detection performance. Will investigate various polarized sensor designs for vehicular, dismounted Soldier, and UAS mountable configurations enabling wider field of regard terrain coverage. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 funding from the Sensors for Autonomous Operations and Survivability effort is realigned to the Multi-Mission Payload effort in this Project.	-	-	5.988	-	5.988
Title: Automated Threat Cueing ***Description:*** Investigates, matures and validates novel image processing and threat recognition and detection methods to enable automated search and detection of open and concealed threats for cueing and target hand-off to maintain overmatch via speed in cluttered environments. ***FY 2021 Base Plans:*** Will develop threat cueing algorithms utilizing EO/IR, novel compact ground penetrating radar, and position sensors for on-the-move target detection and tracking. Will research novel two-dimensional and three-	-	-	5.671	-	5.671

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
dimensional based algorithms utilizing exploitable features and signatures of threats in close combat open terrain scenarios. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 funding from the Sensors for Autonomous Operations and Survivability effort is realigned to the Automated Threat Cueing effort in this Project.					
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.694	-	-	-
Accomplishments/Planned Programs Subtotals	-	15.283	38.154	-	38.154

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BG2: *Modeling and Simulation for MUMT Technology*	-	0.000	3.966	3.397	-	3.397	11.054	11.277	7.846	7.846	0.000	45.386

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: Mobility in Complex Urban Environments	-	3.951	-	-	-
Description: This effort develops real-time mobility warning technology for manned and unmanned ground vehicles to include a real-time hardware-in-the-loop simulation environment to investigate autonomous vehicle maneuver, matures mobility obstacle detection algorithms, and refines near real-time mobility prediction software in the urban environment.					
FY 2020 Plans:					

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Develop and improve a simulation environment to investigate autonomous vehicle maneuver; develop software to automatically detect mobility obstacles in near real-time and mature sensor fusion methods; and refine mobility algorithms for near real-time predictions. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort is realigned to the Simulation Tools for CoVeR effort within this Project to support the PE 0602145A (Next Generation Combat Vehicle Technology) / BF3 (Combat Vehicle Robotics (CoVeR)) Project.					
Title: Simulation Tools for CoVeR ***Description:*** This effort develops M&S capabilities to evaluate hardware and software technologies enabling battlefield autonomy in complex environments and adaptive learning algorithms for predicting mobility performance in challenging environments. ***FY 2021 Base Plans:*** Will develop M&S tools for autonomous vehicle design at the component level for successful maneuver in unstructured environments; will develop analytical tools for predicting autonomous maneuver performance in unstructured environments. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort is realigned from the Mobility in Complex Urban Environments effort within this Project.	-	-	3.397	-	3.397
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.015	-	-	-
Accomplishments/Planned Programs Subtotals	-	3.966	3.397	-	3.397

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 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 2021 Army			Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BG6: *Advanced Concepts for Active Defense Technology*	-	0.000	53.469	45.983	-	45.983	43.081	47.203	47.651	49.626	0.000	287.013

Note

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

A. Mission Description and Budget Item Justification

This Project researches advanced materials and mechanisms to defeat the most common and most dangerous threats that are expected to be encountered by our ground forces in the near, mid and far term. Work conducted in this Project will result in concepts for Adaptive and Cooperative Protection of ground combat vehicles. Additionally, research will focus on subcomponent/component models to predict performance of early concepts and the means to evaluate effectiveness on ground platforms. The Project will balance developments of active threat defeat measures with the necessary advanced passive and active components to provide solutions which will help meet the requirements of current and next generation ground tactical and combat vehicles.

This Project is coordinated with and transition to Projects in PE 0603462A (Next Generation Combat Vehicle Advanced Technology) and builds upon weapon target interaction research in PE 0602144A (Ground Technology) and PE 0601102A (Defense Research Sciences) / Project AA7 (Mechanics and Ballistics).

The cited work is consistent with Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy. Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle (NGCV).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: Computational and Experimental Capability	-	4.565	6.532	-	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					

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
and magneto-hydrodynamic target interactions. This work allows for predicting armor performance and understanding mechanisms, regardless of vehicle platform, with improved and quantified confidence. This effort leverages the Department of Defense and Department of Energy (DOE) Technical Coordination Group Memorandum of Agreement and directly leverages DOE investments in computational platforms for problems in solid dynamics and impact mechanics. ***FY 2020 Plans:*** Will perform limited verification and validation assessments of computational capability; will transition impact mechanics computational models to DOE to further enhance armor design and experimental computational capability; continued improvement and transition of computational modeling and simulation capabilities to improve associated design tools; determine physical mechanisms that contribute to multi-material armor design by increasing imaging and velocity measuring diagnostic capability as well as design of novel experiments. ***FY 2021 Base Plans:*** Will increase computational modeling capability to predict performance of hybrid armor protection mechanisms during threat impact; develop machine learning methods for terminal effects interaction with protection mechanisms; develop diagnostic capability to capture three-dimensional x-ray imagery of experimental threat impacts. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.					
Title: Multi-Threat Armor Technologies ***Description:*** This effort develops multi-threat hybrid armor technologies incorporating both active and passive mechanisms for ground vehicle systems that are effective against future conventional weapons and evolving improvised threats including kinetic and chemical energy as well as blast threats. ***FY 2020 Plans:*** Will computationally and experimentally explore novel passive, reactive, and active armor protection concepts in support of next generation combat vehicle protection; continue to improve understanding of hybrid armor multi-hit capabilities; continue to evaluate promising multi-threat armor designs utilizing hybrid electromagnetic armor/energetic technologies; explore top attack protection designs and potential mechanisms; develop active lightweight kinetic energy penetrator defeat mechanisms. Validate performance to Technical Readiness Level	-	9.110	7.214	-	7.214

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
(TRL) 4 for most promising designs for transition to PE 0603462A (Next Generation Combat Vehicle Advanced Technology). ***FY 2021 Base Plans:*** Will design armor mechanisms and technologies to defeat a wide range of threats to include medium and large caliber projectiles, anti-tank guided missiles, and rocket propelled grenades through the use of high performance computing, analytic modeling, and laboratory experiments; design an optimized vehicle hull concept that includes adaptive and active protection concepts for a combined threat suite through computational and experimental methods. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change 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. ***FY 2020 Plans:*** Will develop lightweight armor for protection against Kinetic Energy (KE) and Chemical Energy (CE) threats. Will utilize advanced multi-physics computational tools developed under the computational experimental capability effort to conduct parametric analysis of threat-target interactions. The results of this analysis will aid the design of advanced armor concepts that will undergo physical experimentation (ballistic testing) to validate performance. The most promising concepts will be further developed and transitioned to PE 0603462A (Next Generation Combat Vehicle Advanced Technology) for component development and maturation. ***FY 2021 Base Plans:*** Will design and develop armor technologies to defeat top-attack munitions using modeling, simulation, and experimental techniques; conduct experiments to explore electro-magnetic protection mechanisms and	-	5.683	7.217	-	7.217

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
associated physics for armor technologies and use modeling and simulation in conjunction with the experimental results to evaluate the integration of multiple technologies to provide electro-magnetic protection mechanisms. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.					
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 2020 Plans:*** Will continue to mature selected adaptive armor mechanisms and conduct additional experiments against challenging threats; will continue to explore soft-kill countermeasures in conjunction with novel threat independent protection mechanisms coupled with an integrated threat warning sensor capability. ***FY 2021 Base Plans:*** Will design a countermeasure and launch mechanism to defeat anti-armor threat weapons implemented in a novel manner to increase protection coverage. Will utilize modeling, simulation, and experimental capabilities to develop adaptive armor protection mechanisms to defeat current and emerging threats. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	9.663	11.808	-	11.808
Title: Emerging Overmatch Technologies ***Description:*** This effort supports the development and demonstration of lethality and protection concepts that re-establish overmatch for the next generation of manned and unmanned combat platforms. It will tightly couple scientific research within a campaign of learning to form technology concepts for battlefield domination against current and future threats. This research will heavily leverage other efforts within PE 0602145A (Next Generation Combat Vehicle Advanced Technology) and PE 0603462A (Next Generation Combat Vehicle Advanced Technology).	-	1.752	2.216	-	2.216

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
FY 2020 Plans: Will evaluate coupled lethality and protection concepts; will continue to explore advanced protection and lethal mechanisms to enhance the next generation combat vehicle and small autonomous systems. ***FY 2021 Base Plans:*** Will conduct validation experiments to determine the effects of coupling of autonomy protection and lethality concepts. Will partner with The Research and Analysis Center (TRAC) to conduct Advanced Warfighting Simulation scenario iterations and evaluate combat effectiveness of these concepts. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.					
Title: Survivability/Lethality/Vulnerability Analysis Tools and Methodology ***Description:*** This effort devises state-of-the-art survivability/lethality/vulnerability methodologies to dynamically model the interaction of conventional ballistic threats against future weapon systems. ***FY 2020 Plans:*** Will develop indirect and precision fire vulnerability and lethality models by investigating methodologies to provide sensitivity analyses on burst height, angle of fall, azimuth and elevation including lethal mechanisms and collateral hazards. Will examine physics-based finite element vulnerability and lethality models by exploring enhanced methods and tools for analysis of underbody threats, blast effects, fire, and combined effects. Will develop personnel vulnerability modeling by investigating models of variability in human morphology and anatomy, including the standard 95th percentile male and female warfighter. Will refine advanced visualization and interactive modeling techniques by developing scene-based models (including terrain) of multiple, complex engagements. ***FY 2021 Base Plans:*** Will complete development and validation of lethality and vulnerability analysis methods that account for multi-hit effects; models will be tailored to assess NGCV weapon systems and effects of direct fire ammunition on NGCV protection technologies; refine and demonstrate effectiveness of smart NGCV munitions in contested and degraded environments of multi-domain operations; investigate vulnerabilities of Artificial Intelligence associated with cognition capabilities provided by sensors which can be degraded when operating in contested environments and explore implications of these vulnerabilities on machine learning performance; investigate the	-	4.768	5.248	-	5.248

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
implications of vulnerabilities to robotic combat vehicles on manned-unmanned teaming performance; validate models for active protection systems and extend them to investigate adaptive protection systems. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.					
Title: Warrior Injury Assessment Manikin (WIAMAN) ***Description:*** This Project develops an improved demonstrator blast test manikin, data acquisition system, and injury prediction methods and tools that incorporate new medical research and which provides an improved capability to measure and predict skeletal injuries for vehicle occupants during under-body blast events. ***FY 2020 Plans:*** Will perform experimental testing and validation of WIAMAN performance. Additional match pair testing will be conducted to confirm Advanced Technology Demonstration (ATD) performance to cadaveric specimens. Subcomponent and component certification testing will be completed to confirm data reliability. ATD performance experiments will be conducted to validate performance to requirements. The development of Finite Element Model tools will be completed and validated to allow for accurate pre-shot predictions. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Effort completes in FY20.	-	1.136	-	-	-
Title: Ground Systems Active Defense Technology Research ***Description:*** This effort contributes to the Army's ground vehicle survivability by developing technologies which electronically or physically defeat an incoming threat before it contacts the vehicle. These technologies involve sensors and effectors interacting with an incoming threat to disrupt or destroy in while it is in flight or before it is even fired at a vehicle. This effort designs and develops modern armors that directly complement and are optimized to work with active defense technologies in order to implement sophisticated mass efficient mechanisms and leverage investments in materials to act as a system for the defeat of advanced threats and active protection system residuals. This effort designs and develops active blast mitigation technologies to counter the effects of underbody attacks to ground vehicles. This effort will also design and develop the required advanced structures required to accommodate active blast mitigation technologies into vehicles. The design of the structure and active defense technology is critical to an effective blast survivability solution. ***FY 2020 Plans:***	-	14.370	5.748	-	5.748

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Will perform requirements definition and lab scale performance validation of a small flyout countermeasure. Will begin conducting research into component packaging and integration methods and concepts, including complementary base vehicle armor components to capture residual fragments from countermeasure engagements. Packaging and integration subcomponent tests will be conducted to feed design trade studies. Initial component designs for countermeasure and base vehicle armor will be developed and analyzed. Will design and develop an advanced soft-kill countermeasure technology. Will conduct testing to capture performance characteristics of the soft-kill countermeasure technology to validate the feasibility and effectiveness against advanced and emerging threats. Will build upon FY19 requirements definition and lab scale performance validation of advanced Improvised Explosive Device concepts and advanced active blast mitigation systems. Initial component designs will be developed and analyzed. ***FY 2021 Base Plans:*** Will conduct experiments to baseline current platform survivability solutions to determine effects of residual debris from an Active Protection System (APS) engagement on protection levels for ground platforms. Will investigate if residual debris impacts to explosive reactive armor introduces a vulnerability to ground vehicles. Will design armor solutions that balance requirements for protection from threat projectiles and APS residual projectiles and validate the concept to use armor and occupant protection technologies for vehicle survivability and soldier protection. Will develop test methods for evaluating occupant protection technologies to mitigate injuries resulting from APS engagement residual effects. Will leverage modeling and simulation to predict and potentially enhance performance of protection systems. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This effort was decreased to focus on more mature technologies and capabilities in PE 0603462A (Next Generation Combat Vehicle Advanced Technology) / BG7 (Ground Systems Active Defense).					
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	2.422	-	-	-
Accomplishments/Planned Programs Subtotals	-	53.469	45.983	-	45.983

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BG8: *Obscuration Technology*	-	0.000	4.070	2.620	-	2.620	2.675	2.729	2.758	2.786	0.000	17.638

Note

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

A. Mission Description and Budget Item Justification

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

The cited work is consistent with the Under Secretary of Defense for Research and Engineering Priority focus areas and the Army Modernization Strategy. Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle (NGCV).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: Obscuration Technologies for Active Protection Systems ***Description:*** This effort investigates dissemination technologies for various obscurants. ***FY 2020 Plans:*** Will conduct modeling and analysis of new vehicle protection concepts to determine effectiveness of obscurant dissemination. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding for this effort ends after FY20. Products are transitioned to PE 0603462 (Next Generation Combat Vehicle Advanced Technology) / BG7 (Ground Systems Active Defense Advanced Tech) for technology maturation.	-	1.407	-	-	-
Title: Obscuration Enabling Technologies	-	2.478	2.620	-	2.620

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
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 2020 Plans:*** Will continue to mature and characterize advanced bi-spectral, advanced microwave, and spectrally selective obscurants. Will continue to investigate effects against various threat technologies (e.g., sensors, missile seekers) for various obscurants. ***FY 2021 Base Plans:*** Will validate packing and dissemination techniques for advanced obscuration materials including bi-spectral, advanced microwave, and spectrally selective obscurants . Will mature advanced bi-spectral materials for screening obscuration module. Will perform threat modelling for unmanned ground and aerial systems sensor systems. Will evaluate obscuration technologies against threat systems to determine probability-of-hit for vehicle platforms. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Adjustment to economic assumptions.					
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.185	-	-	-
Accomplishments/Planned Programs Subtotals	-	4.070	2.620	-	2.620

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BG8 / *Obscuration Technology*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BH2 / *C4ISR Modular Autonomy Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BH2: *C4ISR Modular Autonomy Technology*	-	0.000	4.874	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.874

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602709A Night Vision Technology
* Project H95 Night Vision and Electro Optic Technology

In FY21 this Project will realign to:
PE 0602145A Next Generation Combat Vehicle Technology
* Project BF9 Sensors for Autonomous Operations and Surv Tech

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: C4ISR Modular Autonomy Technology	-	4.653	-	-	-
Description: Investigates and matures embedded processing algorithms utilized in soldier systems and platforms to improve the warfighter?s decision efficiency and ability to perform Intelligence, Surveillance, and Reconnaissance (ISR), Target identification and discrimination					
FY 2020 Plans:					

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BH2 / *C4ISR Modular Autonomy Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Will develop foundational signal and image processing algorithms; will build algorithm framework to support cognitive autonomous processing; will identify functions to assist human operators. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** The funding in this effort is realigned in FY21 to BF9 (Sensors for Autonomous Operations and Surv Tech) in this same PE for higher priority modernization needs .					
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.221	-	-	-
Accomplishments/Planned Programs Subtotals	-	4.874	-	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BH5: *Platform Electrification and Mobility Tech*	-	0.000	10.024	21.275	-	21.275	19.989	16.221	13.580	18.689	0.000	99.778

Note

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

A. Mission Description and Budget Item Justification

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

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

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

Work 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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: AVPTA - Energy Storage	-	0.762	-	-	-
Description: This effort develops and matures advanced energy storage technologies to improve power and energy performance and safety for vehicles. Higher energy stored with less space and weight increases vehicle efficiency and range. Ensures electrified ground vehicles have enough power for mobility, silent watch, and enables energy based capabilities including electromagnetic armor and directed energy weapons.					

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
FY 2020 Plans: Research energy storage, battery chemistry and packaging technologies to determine approach that can be developed to meet the needs of hybrid and all-electric drive combat and tactical platforms. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort is realigned to PE 0603462A (Next Generation Combat Vehicle) / BH6 (Platform Electrification and Mobility Advanced Technology).					
Title: Novel Propulsion Research ***Description:*** This effort performs research to assess and evaluate the optimal electrified propulsion system configuration for future military tactical and combat ground vehicle applications. This effort will investigate and model parallel hybrid-electric, series hybrid-electric, fuel cell and all-electric propulsion systems for the future military vehicle applications. Research is required to understand how electrified propulsion may impact future fleet mobility requirements, soldier operational scenarios, operational energy reduction, enablement of future lethality and defensive systems, sensors, and ancillary electrical loads. Novel propulsion systems such as fuel cells, high speed diesel engines, mega-watt generators, quad sprocket tracked and multi-drive wheeled mobility, as well as the logistic support and infrastructure requirements will be investigated. ***FY 2020 Plans:*** Will perform comprehensive research of novel propulsion system configurations for future military tactical and combat ground vehicle applications. Will explore current and future military requirements, potential novel propulsion system technology, component maturation, performance modeling, simulated soldier operational scenarios, Joint Operational Energy Initiative assessments, and logistical support. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort is realigned to PE 0603462A (Next Generation Combat Vehicle) / BH6 (Platform Electrification and Mobility Advanced Technology).	-	1.476	-	-	-
Title: Platform Electrification and Mobility Research ***Description:*** This effort develops technologies required to electrify both manned and unmanned Next Generation Combat Vehicle platforms. The effort develops a modular and scalable electrification architecture. The effort develops technologies to increase electric power such as a high voltage/temperature generator, high power/ temperature power electronics, electric drive motors, and energy storage. Electrification of these	-	7.330	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
platforms will enable advanced lethality and protection systems, reduced battlefield fuel consumption, and provide new capabilities such as burst acceleration, extended silent mobility and silent watch. ***FY 2020 Plans:*** Will develop and model an electrification architecture that supports hybrid, fuel cell and all-electric powertrains and that is scalable for both manned and unmanned tactical and combat vehicles. Will develops high voltage/ high temperature generator, power electronics, electric motor drives, and energy storage system. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 work in this effort is realigned to Scalable Electrification and Control Architecture Research, Platform Electrification Research, and Advanced Mobility Research efforts in this Project.					
Title: Scalable Electrification & Control Architecture ***Description:*** This effort develops the power distribution and control components to implement a common, scalable, electrified vehicle power architecture to enable advanced lethality and protection capabilities, fast vehicle charging from the grid, and silent mobility on combat platforms across light to heavy weight classes. This power architecture enables the hybrid electric, fuel cell electric, and all-electric powertrains. ***FY 2021 Base Plans:*** Will develop high voltage power distribution components that enable electrified powertrains. Will develop the high voltage power converter to enable advanced lethality/protection capabilities and high voltage battery storage. Will develop import/export power converter to enable fast vehicle charging from local power sources. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Work in this effort was conducted in the Platform Electrification and Mobility Research effort in FY20.	-	-	1.996	-	1.996
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 2021 Base Plans:*** Will design internal components for a high voltage power system electric generator and high power inverter. Will design electric drive motors. Will design thermal management system for a modular electrification architecture. Will design electric turret drive. Will investigate novel battery chemistries that could provide up to four times	-	-	11.752	-	11.752

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
more energy storage density than current batteries. Will design and develop modules for a modular high voltage energy storage system. Will design mobility/silent watch range extender. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Work in this effort was conducted in the Platform Electrification and Mobility Research effort in FY20 and was also increased in FY21 to accelerate platform electrification capabilities for NGCV.					
Title: Advanced Mobility Research ***Description:*** This effort develops a lightweight composite running gear system for medium combat vehicle applications which offers significantly reduced system weight, maintenance, noise and vibration over conventional running gear systems. Advanced composite tracks coupled with low cost, low complexity suspension systems improve operational capability via increased mobility. ***FY 2021 Base Plans:*** Will research novel running gear systems using composite materials to reduce weight. Will investigate new joining methods for rubber band track connections. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Work in this effort was conducted in the Platform Electrification and Mobility Research effort in FY20.	-	-	3.396	-	3.396
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	-	-	1.563	-	1.563

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
connected to electrical motors and generators to reduce size and weight with increased reliability and performance providing increased torque, speed and range. Results of the research informs the Novel Propulsion Research effort in this Project. ***FY 2021 Base Plans:*** Will perform experiments on electrical conversion design concepts from PE 0602145A (Next Generation Combat Vehicle Technology), Project BH7 (Enhanced VETRONICS Technology) to understand performance and operational parameters of the components; investigate techniques to improve power conversion component performance through advanced control techniques and methodologies; investigate methods to monitor energy use and losses in real time; analyze performance of power modules utilizing AI/ML control methods to experimentally determine performance improvement enabled by use of reinforcement machine learning algorithms; analyze performance of the 200:1 gear ratio magnetic gear; and initiate improvement for reduced weight design to determine performance envelope. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This effort is realigned in FY21 from PE 0602145 BF8 (Artificial Intelligence & Machine Learning Tech) Project to better align the work being performed					
Title: Power Electronic Components and Materials ***Description:*** This effort investigates and develops electric conversion technologies to reduce size and weight while increasing performance and capabilities to support current and future mission loads and provide improved military vehicle mobility. Research focuses on semiconductor power switches, power switch modules and packaging, and power switch module thermal management. Investigation high voltage/high frequency power semiconductor materials and devices concentrates on efficient power switching under militarily relevant temperature ranges. Development of multi-disciplinary parametric design optimization software tools and multi-functional package structures provides advances in device packaging technology to fully realize device performance improvements. Results of the research will inform the Novel Propulsion Research effort in PE 0602145A (Next Generation Combat Vehicle Technology) / BH5 (Platform Electrification and Mobility Technology). ***FY 2021 Base Plans:*** Will determine performance of Gallium Nitride based power device process enhancements through modeling and device performance analysis; develop fabrication processes to enable wide?band-gap and ultra-wide-band-gap semiconductor device technologies; incorporate magnetic material analysis algorithms to expand	-	-	2.568	-	2.568

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
the design envelope for the parametric optimization simulation tool used in this effort; analyze and investigate the performance of metallic phase change thermal management techniques; determine performance of power module designs for 20 kiloWatts per Liter (kW/L) and 25 kiloWatts per kilogram (kW/kg) power ratings as well as examine concepts, designs, and processes to achieve objective goal of 40kW/L and 50 kW/kg power ratings. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort is realigned from PE 0603462A (Next Generation Combat Vehicle) / BH7 (Enhanced VETRONICS Technology)					
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.456	-	-	-
Accomplishments/Planned Programs Subtotals	-	10.024	21.275	-	21.275

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BH7 / *Enhanced VETRONICS Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BH7: *Enhanced VETRONICS Technology*	-	0.000	3.603	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.603

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602601A Combat Vehicle and Automotive Technology
* Project H91 Ground Vehicle Technology
PE 0602705A Electronics and Electronic Devices
* Project EM8 High Power and Energy Component Technology

In FY21 this Project will realign to:
PE 0602145A Next Generation Combat Vehicle Technology
* Project BH5 Platform Electrification and Mobility Tech

A. Mission Description and Budget Item Justification

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

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy. Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle (NGCV).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: Electronic Components and Materials Research	-	3.439	-	-	-
Description: This effort investigates material, device and module technologies to reduce weight, volume and energy losses for ground tactical and combat vehicles electrification while providing enhanced mission effectiveness through smart operation. Technologies provide devices and modules for high power hybrid-electric					

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BH7 / *Enhanced VETRONICS Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
propulsion, electric power generation and conversion, and smart power distribution. Research addresses current and future Army-unique performance and operational requirements for ground vehicle mobility. ***FY 2020 Plans:*** Will investigate and characterize high-power devices that enable high-power density and efficient electrical propulsion, and electrification of ground vehicle sub-systems; will explore integration of metallic phase change thermal management techniques to manage electrical power module and component temperatures; will develop multi-discipline parametric optimization tool for power packaging; and will study advanced materials and device structures to determine the potential of utilizing AlGaN materials for high-power application to NGCV priorities. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This effort is realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / BH5 (Platform Electrification and Mobility Tech) to better reflect the work to be conducted.					
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.164	-	-	-
Accomplishments/Planned Programs Subtotals	-	3.603	-	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BH9: *Protection for Autonomous Systems Tech*	-	0.000	2.548	1.499	-	1.499	1.499	1.998	2.098	2.098	0.000	11.740

Note

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

A. Mission Description and Budget Item Justification

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

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy. Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle (NGCV).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: Protection for Autonomous Systems	-	2.432	1.499	-	1.499
Description: This effort contributes to the Army's ground platform risk reduction efforts which that seek to address technical challenges of survivability and protection for autonomous systems. Specifically, this effort focuses on developing protection concepts for unique unmanned systems to ensure autonomous ground vehicles can continue their mission in contested environments.					
FY 2020 Plans: Will determine the potential vulnerabilities to an autonomous ground combat vehicle through modeling and simulation using physics-based tools. Will develop the capability to validate those vulnerabilities in a laboratory environment.					
FY 2021 Base Plans:					

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BH9 / *Protection for Autonomous Systems Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Will evaluate the vulnerability of autonomous ground system components such as sensors, enabling autonomous maneuver against threats to include electromagnetic effects. Evaluation will be conducted in order to understand potential threat-based mission impacts and degraded operation of unmanned system components to inform future hardening activities for military applications. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding reduced for higher priority NGCV efforts.					
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.116	-	-	-
Accomplishments/Planned Programs Subtotals	-	2.548	1.499	-	1.499

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BI2: *Sensor Protection Technology*	-	0.000	10.584	10.340	-	10.340	10.599	10.822	10.952	10.953	0.000	64.250

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: Sensor Protection Technology	-	6.448	6.189	-	6.189

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
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 2020 Plans:*** Will mature emerging optical window technologies to reduce the amount of laser energy arriving on a thermal sensor before it has a chance to reflect off of the focal plane array. Will investigate novel threat reduction technologies to protect emerging high sensitivity uncooled longwave infrared sensors. Will determine mobile camouflage system susceptibility to electro-optic/infrared cameras. ***FY 2021 Base Plans:*** Will investigate new protective sensor coatings that maximize transmission for sensor frequency bands while minimizing energy transmission of other frequencies including lasers to protect sensor components while still meeting environmental performance and durability requirements. Will develop and evaluate new designs to reduce optical cross section (OCS) and resist sensor damage for emerging large format electro-optical/infrared focal plane arrays. Will evaluate concealment performance of camouflage technologies in all environments against reflective, emissive, and radar threat sensors. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort is reduced to support Army modernization priorities.					
Title: Laser Protection Technologies ***Description:*** This effort develops new materials and devices for the protection of Army sensors and eyes behind day-view optical sights from a variety of laser threats. This research utilizes a combination of technologies based on the nature of the different threats, as well as the fundamental differences in sensors operating over different frequency ranges. Passive optical limiting materials that block specific frequency bands of light will be investigated and developed for the visible and short-wave infrared (SWIR) spectrum, and active man-made material-based solutions will be investigated for uncooled sensors in the long-wave infrared. Vulnerability of sensors and optical sensor systems will be studied against high-power and ultra-short pulsed laser threats to determine protection requirements. ***FY 2020 Plans:*** Will investigate tunable mid-wave infrared filter designs and improve tunable long-wave infrared filters based on previous experiments; will improve multi-chromophore solid-state optical limiter to increase operational	-	3.655	4.151	-	4.151

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
bandwidth; will investigate pulsed wave laser limiter concepts in the mid-wave infrared; and will improve high-power continuous wave laser protection concepts. ***FY 2021 Base Plans:*** Will analyze results of study previously conducted on threats to sensor systems and develop optical system protection concepts to mitigate the impact of the study findings; validate ultrashort laser sensor focal plane array damage protection materials; conduct high-power laser experiments to test protection concepts; investigate the capabilities of tunable infrared filters coupled with shape memory alloy shutters for protection of uncooled infrared sensors. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.					
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.481	-	-	-
Accomplishments/Planned Programs Subtotals	-	10.584	10.340	-	10.340

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BI4: *Materials Application and Integration Tech*	-	0.000	8.313	7.689	-	7.689	7.819	7.972	8.057	8.058	0.000	47.908

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

Work in this Project leverages research from PE 0601102A (Defense Research Sciences) / Project AA7 (Mechanics and Ballistics) and 0602144A (Ground Technology) / Project BL1 (Materials and Manufacturing Research Technology). This work is also coordinated with PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: Lightweight Armor Materials and Processes for Vehicle Protection	-	3.782	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Description: This effort conducts applied research to design, develop and evaluate lightweight armor materials and structures, investigate novel processing methodologies for cost effective manufacturing, use existing and emerging modeling and simulation tools to enable formulation of lightweight, frontal, and structural armor materials for current and future platform applications. This effort also explores ground vehicle structural mechanics and dynamics technologies to improve damage tolerance, durability, fatigue-resistance, and dynamic response (i.e., shock, vibration, harshness, and damping). ***FY 2020 Plans:*** Will investigate new metal alloys, including corrosion resistant magnesium alloys and lighter weight high hardness steels; will assess the causes of delayed cracking in high hardness steel armor by performing stress corrosion cracking characterization on a statistically significant number of armor plates; will develop novel composite design capabilities to enable improved, lightweight ballistic resistance using first principles methods and techniques. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This effort is combined with the Novel Armor Materials and Processes for Vehicle Protection effort in this Project to better reflect combat vehicle protection materials work.					
Title: Novel Armor Materials and Processes for Vehicle Protection	-	2.387	7.689	-	7.689
Description: Develop novel metal alloys and associated processes through the scale-up and exploitation of revolutionary new metal alloys, which have demonstrated capabilities to overcome traditional engineering trade-offs (e.g., strength and ductility) with exceptional high temperature stability. ***FY 2020 Plans:*** Will develop scalable processing methods for strengthened nanocrystalline iron materials and generate initial ballistic data; will investigate the processing of aluminum alloys with novel chemistries for the generation of hydrogen. ***FY 2021 Base Plans:*** Will investigate performance of nanocrystalline and novel high-hardness metal alloys, validating their use for ballistic protection applications; investigate corrosion-resistant magnesium alloys and validate for ballistic protection and structural applications. ***FY 2020 to FY 2021 Increase/Decrease Statement:***					

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
The Lightweight Armor Materials and Processes for Vehicle Protection effort is realigned into this effort to better reflect vehicle materials protection work.					
Title: Advanced Vehicle Power Technology Alliance Materials ***Description:*** This effort develops and matures lightweight materials and joining technologies to enable lighter, more fuel-efficient tactical and combat vehicles with superior mobility and protection of both vehicles and occupants. Lighter materials and advances in joining technologies such as multi-material and dissimilar material joining will lead to lightweight military vehicle structures. ***FY 2020 Plans:*** Will continue to develop lightweight materials such as iron, manganese, aluminum (FeMnAl) alloy; magnesium and high strength aluminum alloys; will validate material and component performance through experiments on manufacturability, blast/ballistic performance, machinability, weldability, corrosion and stiffness; will investigate and develop solid state joining methods such as friction stir dovetailing and scribing for joining dissimilar materials; will develop, characterize and validate innovative weld wire materials for joining high strength aluminum alloys and advanced high strength steels; will Investigate emerging breakthrough techniques in dissimilar material joining. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This effort is realigned in FY21 to PE 0603462A (Next Generation Combat Vehicle Advanced Technology) / BI5 (Materials Application and Integration Adv Tech).	-	1.767	-	-	-
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.377	-	-	-
Accomplishments/Planned Programs Subtotals	-	8.313	7.689	-	7.689

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 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 2021 Army			Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BI9: *Vehicle System Security Technology*	-	0.000	2.951	2.777	-	2.777	2.827	2.253	2.125	3.572	0.000	16.505

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: Vehicle System Security Technology	-	2.817	2.777	-	2.777
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.					

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
FY 2020 Plans: Will develop quantifiable security and resiliency metrics to inform digital protection requirements for future ground vehicle capabilities; will develop an advanced data bus technology with embedded cyber-resilient defensive agents to protect against offensive and malicious attacks and ensure continued freedom of maneuver in the cyber warfighting domain; will develop resilient technologies for real-time threat detection and operation in near-peer cyber-contested environments. ***FY 2021 Base Plans:*** Will develop resilient runtime functionality in vehicle electronic components in a security centered databus and Vehicle Integration of Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR)/Electronic Warfare Interoperability (VICTORY) architecture-compliant security protocols. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.					
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.134	-	-	-
Accomplishments/Planned Programs Subtotals	-	2.951	2.777	-	2.777

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BJ2: *Tactical and Navigation Lasers Sensors Technology*	-	0.000	4.990	5.453	-	5.453	5.562	5.673	5.737	5.794	0.000	33.209

Note

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

A. Mission Description and Budget Item Justification

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

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy. Work in this Project supports the Army Modernization Priority Next Generation Combat Vehicle (NGCV), Soldier Lethality, and Future Vertical Lift (FVL).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: Tactical and Navigation Lasers Sensors Technology	-	4.763	5.453	-	5.453
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.					
FY 2020 Plans:					

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Will develop mid-wave infrared component technology and conduct field trial to evaluate range performance and optical detection capabilities. Will investigate laser detection and ranging applications to support autonomous vehicle operations. ***FY 2021 Base Plans:*** Will investigate emerging longwave infrared (LWIR) laser sources and integrate with a novel solid state laser in order to achieve a LWIR solution with sufficient power to meet battlefield needs. Will design and build brassboard demonstrator for evaluation in a laboratory environment. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.					
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.227	-	-	-
Accomplishments/Planned Programs Subtotals	-	4.990	5.453	-	5.453

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BJ3 / *Hydrogen Based Combat System Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BJ3: *Hydrogen Based Combat System Technology*	-	0.000	7.127	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	7.127

Note

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

In FY21 this Project is realigned to:
PE 0602145A Next Generation Combat Vehicle Technology:
* Project BH5 Platform Electrification and Mobility Tech

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: Hydrogen Based Combat System Technology	-	6.803	-	-	-
Description: This effort develops the required fuel cell controls and hydrogen generation technologies required to leverage commercial development in hydrogen based fuel cells to create energy efficient combat and tactical systems.					
FY 2020 Plans:					

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BJ3 / *Hydrogen Based Combat System Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Will develop the controls strategy for combining multiple commercial fuel cell stacks into one combat vehicle power module; will develop an aluminum based hydrogen generation system that can provide hydrogen to vehicles effectively and efficiently. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This effort is realigned in FY21 to PE 0602145A (Next Generation Combat Vehicle Technology) / BH5 (Platform Electrification and Mobility Tech) to support Army Modernization Priorities.					
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.324	-	-	-
Accomplishments/Planned Programs Subtotals	-	7.127	-	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BJ7 / *Detection of Explosive Hazards Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BJ7: *Detection of Explosive Hazards Technology*	-	0.000	11.882	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	11.882

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602712A Countermine Systems
* Project H24 Countermine Tech

In FY21 this Project will realign to:
PE 0602145A Next Generation Combat Vehicle Technology
* Project BF9 Sensors for Autonomous Operations and Surv Tech

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: Detection of Explosive Hazards Technology ***Description:*** This effort focuses on designing and developing novel component technology for detection and defeat of mines, minefields, IEDs and other explosive hazard threats for manned and unmanned vehicles.	-	11.342	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BJ7 / *Detection of Explosive Hazards Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Artificial intelligence and machine learning tools will be exploited to provide autonomous capabilities and enable increased survivability through greatly increased mine detection standoff ranges. ***FY 2020 Plans:*** Will design modular, adaptive, reduced size, weight and power explosive hazard (EH) detection payloads for incorporation on small unmanned aerial and ground vehicles; will determine sensor component performance against expected threats through collection and analysis of data from different standoff sensor combinations to include close-in sensors; will validate different sensor modalities to determine ideal component mix for EH detection in urban and arctic environments; will mature EH detection algorithms through their application against novel threat data sets; will validate sensor fusion using results of data collections will investigate techniques to exploit vulnerabilities of near peer EH threats. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This effort is realigned in FY21 to 0602145A (Next Generation Combat Vehicle Technology) / BF9 (Sensors for Autonomous Operations and Survivability Technology) for higher priority modernization areas.					
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.540	-	-	-
Accomplishments/Planned Programs Subtotals	-	11.882	-	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BJ9: *Autonomous Mobility Tech*	-	0.000	3.060	2.498	-	2.498	3.996	0.000	0.000	0.000	0.000	9.554

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: Big Data Storage Techniques	-	2.891	-	-	-
Description: This effort develops techniques and technologies for storage of machine learning data sets to be used collaboratively for Army research.					
FY 2020 Plans:					

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Will develop automated data labeling/cleaning techniques across large amounts of data. Will examine and integrate storage requirements of different types of datasets into a unified system. Will integrate hardware and software components for the storage sub-system. Will integrate each step in storage process into a single pipeline for ease of access and use. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding decrease due to this effort completing in FY20 and realigning funding in FY21 to the Formation Control ? Novel Technique Investigation effort in this Project.					
Title: Unmanned Aerial Vehicle (UAV) Mapping ***Description:*** Develop a collaboration of UAV map input for ground vehicle mobility via artificial intelligence and machine learning. ***FY 2020 Plans:*** Will develop UAV and ground vehicle architectures for integration of artificial intelligence. Will integrate existing UAV and ground vehicle architectures into single architecture for collaboration and data passing. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding decrease due to this effort completing in FY20 and realigning funding in FY21 to the Formation Control ? Novel Technique Investigation effort in this Project.	-	0.030	-	-	-
Title: Formation Control ? Novel Technique Investigation ***Description:*** This effort focuses on performing the applied research needed to investigate cutting edge ML techniques to be used for advanced collaborative movement. Areas of investigation here look to advance the utility of ML mobility beyond the current, widely utilized algorithms to allow for more natural coordination of autonomous vehicles and Soldiers. ***FY 2021 Base Plans:*** Will perform thorough survey of cutting edge ML techniques, investigate the algorithms that apply to formation control, and conduct experiments to determine applicability to NGCV. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This funding increase is to conduct important groundwork for formation control and is realigned from the Big Data Storage Techniques and Unmanned Aerial Vehicle Mapping efforts in this Project.	-	-	2.498	-	2.498
Title: FY 2020 SBIR/STTR Transfer	-	0.139	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Description: Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638					
Accomplishments/Planned Programs Subtotals	-	3.060	2.498	-	2.498

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BK2: *Virtual Prototyping Technology*	-	0.000	5.426	8.609	-	8.609	8.482	8.608	8.292	8.316	0.000	47.733

Note

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

A. Mission Description and Budget Item Justification

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

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

Work in this Project supports the Army Modernization Priority NGCV.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: Virtual Prototyping	-	5.180	8.609	-	8.609
Description: This effort addresses technical and integration challenges in the areas of mobility, survivability, lethality, vehicle architecture, and systems integration for the Army's next generation of ground combat vehicles. Specifically, this effort focuses on developing integrated design concepts, performance analysis, identifying					

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
and assessing trade space, and conducting virtual operational experiments for the NGCV. The combination of technical performance and operational feedback provides insights ***FY 2020 Plans:*** WIII generate multiple novel NGCV manned and unmanned system level ground vehicle concepts, assess performance, and conduct soldier involved virtual experiments to provide operational feedback from warfighters on NGCV system designs and technology performance. ***FY 2021 Base Plans:*** Will design and develop new NGCV manned and unmanned ground vehicle concepts. Will integrate new advanced technology components such as lethality and protection systems in a virtual environment. Will conduct analyses, trade studies, and Soldier-in-the-loop virtual experiments to provide Warfighter feedback on design concepts and inform NGCV performance and suggest design paths to improve performance. Will partner with industry to generate additional NGCV ground vehicle design concepts to expand the investigation of enabling technologies and performance for NGCV. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Increased in FY2021 to expand collaboration with industry on the design and development of NGCV system level concepts.					
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.246	-	-	-
Accomplishments/Planned Programs Subtotals	-	5.426	8.609	-	8.609

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602145A / *Next Generation Combat Vehicle Technology*	**Project (Number/Name)** BK2 / *Virtual Prototyping Technology*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BK3: *Next Gen Intelligent Fire Control (NG-IFC) Tech*	-	0.000	1.050	4.196	-	4.196	0.999	0.999	0.000	0.000	0.000	7.244

Note

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

A. Mission Description and Budget Item Justification

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

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy. Work in this Project supports the Army Modernization Priority NGCV.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: Next Generation Intelligent Fire Control Technology	-	1.002	4.196	-	4.196
Description: This effort investigates image sets for computer vision algorithms, target acquisition validation schemes and experimentation of large caliber armament systems.					
FY 2020 Plans: Will conduct experiments with pre-shot hardware for future integration into unmanned ground vehicle system and develop common fire controller components.					
FY 2021 Base Plans: Will validate fire control system components and algorithms for implementing machine learning training; develop new algorithms and models to generate and validate prioritized target lists using documented battlefield metrics; and conduct experiments to collect fire control scenario data to support algorithm/model training and development.					
FY 2020 to FY 2021 Increase/Decrease Statement:					

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
In FY21 funding in this effort is increased to support data collection for algorithm training for machine learning.					
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.048	-	-	-
Accomplishments/Planned Programs Subtotals	-	1.050	4.196	-	4.196

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BK5: *Adv Direct In-Direct Armament Sys (ADIDAS) Tech*	-	0.000	1.190	3.959	-	3.959	12.542	15.084	15.921	17.017	0.000	65.713

Note

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

A. Mission Description and Budget Item Justification

This Project matures and conducts experiments on component technologies for large caliber direct fire light-weight armament systems that will exceed the current capability of 120mm direct fire and be optimized for future operational environment with cross-domain engagement capability. This Project also researches large caliber direct fire munitions to project overwhelming lethality while ensuring maneuver forces remains mobile and sustainable during close-combat engagements at extended ranges.

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

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

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

Work in this Project is related to and fully integrated with the efforts funded in PE 0603462A (Next Generation Combat Vehicle Advanced Technology) and PE 0602141A (Lethality Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Title: Advanced Direct In-Direct Armament System Technology	-	1.136	-	-	-
Description: This effort designs and develops technologies for large caliber direct fire light-weight armament systems that will exceed the current capability of 120mm direct fire cannons and be optimized for future operational environment, including dense urban, with cross-domain engagement capability. Specifically, this effort matures technologies for rapid fire on-the-move at all elevations (direct & indirect), compact ammunition design with advanced ignition, advanced recoil mitigation to reduce impulse and automated ammunition handling and reloading.					
FY 2020 Plans:					

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Will investigate armament system configurations for high elevations and advanced recoil mitigation to reduce impulse. Will develop component technologies for ammunition handling and the primary weapon that support the configurations needed for high elevation and reduced impulse. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This effort has been realigned to the Advanced Lethality ? Kinetic Energy (AL-KE) effort in this Project to better describe the work to be performed.					
Title: Advanced Lethality ? Kinetic Energy (AL-KE) ***Description:*** This effort designs and develops component technologies for large caliber direct fire light-weight armament systems that will exceed the current 120mm direct fire cannon performance for future operational environments, including dense urban, with multi -domain engagement capability. The component technologies that support rapid fire on-the-move (direct & indirect) engagements include: compact ammunition design with advanced ignition, reduced gun impulse on platform through advanced recoil mitigation techniques, and automated ammunition handling and reloading. ***FY 2021 Base Plans:*** Will investigate range-extending technologies for direct fire kinetic energy ammunition with increased propulsion efficiency; will design and develop direct fire kinetic energy cartridge technologies to defeat future threats to ground vehicle systems. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort has been realigned from Advanced Direct In-Direct Armament System Technology in this Project.	-	-	1.485	-	1.485
Title: NGCV Penetrator Technology for Decisive Lethality ***Description:*** This effort develops energy-efficient lethal mechanism technologies for next-generation warheads and projectiles for large-caliber ammunition launched from direct fire weapon systems that maximize the lethality against an array of targets and provide tactical advantage at extended ranges for next generation threats. The results of this research will provide the basis for the lethality required for the next generation of combat vehicles and enable the development of the next generation of ammunition to ensure lethal overmatch throughout the operational environment. ***FY 2021 Base Plans:***	-	-	2.474	-	2.474

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Will develop kinetic energy penetrator concepts for next generation armament systems to enable decisive lethality capabilities for the next generation of combat vehicles including tanks and unmanned platforms. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort is realigned from PE 0602141A (Lethality Technology).					
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.054	-	-	-
Accomplishments/Planned Programs Subtotals	-	1.190	3.959	-	3.959

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 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 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BP5: *Ground Vehicle Technology (CA)*	-	0.000	44.500	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	44.500

Note

Congressional Interest Item funding provided for Ground Vehicle Technology.

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Ground Vehicle Technology.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Prototyping Energy Smart Autonomous Ground Systems ***FY 2020 Plans:*** Prototyping Energy Smart Autonomous Ground Systems	-	10.000
Congressional Add: Highly Electrified Vehicles ***FY 2020 Plans:*** Highly Electrified Vehicles	-	5.000
Congressional Add: Additive Metals Manufacturing ***FY 2020 Plans:*** Additive Metals Manufacturing	-	3.000
Congressional Add: RPG and IED Protection ***FY 2020 Plans:*** RPG and IED Protection	-	3.000
Congressional Add: Modeling and Simulation ***FY 2020 Plans:*** Modeling and Simulation	-	3.000
Congressional Add: Structural Thermoplastics ***FY 2020 Plans:*** Structural Thermoplastics	-	3.000
Congressional Add: Advanced Materials Development for Survivability ***FY 2020 Plans:*** Advanced Materials Development for Survivability	-	10.000
Congressional Add: Autonomous Vehicle Mobility	-	7.500

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
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 2019	FY 2020
FY 2020 Plans: Autonomous Vehicle Mobility		
Congressional Adds Subtotals	-	44.500

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	0.000	138.016	114.404	-	114.404	100.565	100.463	122.860	115.006	0.000	691.314
AM6: *Modular RF Communications Technology*	-	0.000	3.909	3.810	-	3.810	0.000	0.000	10.082	12.173	0.000	29.974
AM8: *Protected SATCOM Technology*	-	0.000	9.600	4.995	-	4.995	1.499	0.000	6.576	8.971	0.000	31.641
AN3: *Non Traditional Waveforms Technology*	-	0.000	3.291	0.000	-	0.000	0.000	4.691	7.804	4.683	0.000	20.469
AN5: *Protected SATCOM-WB Global SATCOM Inter Canc Tech*	-	0.000	0.400	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.400
AN7: *COE - Every Receiver is a Sensor Technology*	-	0.000	3.005	3.062	-	3.062	3.123	3.186	3.222	3.222	0.000	18.820
AN9: *UNT - Every Receiver is a Sensor Technology*	-	0.000	3.850	1.998	-	1.998	2.038	2.079	2.103	2.103	0.000	14.171
AO2: *Stand-In Advanced RF Effects (STARE)*	-	0.000	7.504	4.383	-	4.383	2.051	2.111	2.134	2.134	0.000	20.317
AO4: *Energy Efficient Devices Technology*	-	0.000	5.412	5.473	-	5.473	5.838	5.410	5.470	5.525	0.000	33.128
AO5: *Tag Track and Locate Small Satellites Technology*	-	0.000	4.406	3.834	-	3.834	3.764	3.884	3.926	3.965	0.000	23.779
AP4: *CEMA Camouflage Technology*	-	0.000	9.716	9.841	-	9.841	10.116	9.967	9.809	9.907	0.000	59.356
AP5: *Electronic Warfare Technology*	-	0.000	2.823	2.915	-	2.915	3.012	3.084	3.125	3.156	0.000	18.115
AP7: *Comms/Horiz Int for Army Mod Priorities Tech*	-	0.000	0.500	2.914	-	2.914	2.615	2.964	3.028	3.051	0.000	15.072
AQ2: *EW Techniques Technology*	-	0.000	0.000	0.500	-	0.500	0.500	0.520	0.525	0.525	0.000	2.570
AQ7: *High Tempo Data Driven Decision Tools Technology*	-	0.000	0.000	2.804	-	2.804	0.000	0.000	0.000	0.000	0.000	2.804

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army											Date: February 2020		
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*								
AQ9: *Expeditionary Data to Decisions Technology*	-	0.000	2.000	2.805	-	2.805	4.999	3.287	3.289	0.591	0.000	16.971
AR1: *Robust, Resilient and Intelligent C3I Technology*	-	0.000	8.700	13.775	-	13.775	14.035	14.316	14.476	14.622	0.000	79.924
AR3: *Intelligent Environmental Battlefield Awareness*	-	0.000	0.000	3.007	-	3.007	3.097	3.070	2.133	0.000	0.000	11.307
AR5: *Understanding the Environment as a Threat Technolo*	-	0.000	3.943	2.331	-	2.331	1.980	1.284	0.980	0.990	0.000	11.508
AR7: *Sensing in Contested Environments Technology*	-	0.000	0.000	1.888	-	1.888	1.207	0.985	0.996	0.000	0.000	5.076
AR9: *Persistent Geophysical Sensing-Infrasound Tech*	-	0.000	3.963	3.150	-	3.150	3.456	2.698	2.498	2.274	0.000	18.039
AT2: *Subterranean Detection and Monitoring Technology*	-	0.000	1.600	2.897	-	2.897	0.000	1.956	1.636	1.485	0.000	9.574
AT4: *GeoINT - OPS Merge Technology**	-	0.000	0.000	0.000	-	0.000	0.000	2.033	7.639	6.090	0.000	15.762
AT7: *Network-Enabled GeoSpatial-GEOINT Services Tech*	-	0.000	2.992	4.001	-	4.001	4.692	1.033	0.000	0.000	0.000	12.718
AT9: *Tactical GeoSpatial Information Capabilities Techn*	-	0.000	2.771	4.240	-	4.240	1.798	0.000	0.000	0.000	0.000	8.809
AU3: *Geospatially Enabled Operational Design Technology*	-	0.000	3.173	1.467	-	1.467	1.002	0.000	0.000	0.000	0.000	5.642
AU5: *Automated Analytics for Operational Environment*	-	0.000	3.950	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.950
AU7: *GEOInt/Ops Integration for Multi-echelon Orders**	-	0.000	0.000	0.000	-	0.000	0.000	4.008	1.798	0.999	0.000	6.805
AV3: *Foundational S&T for Network C3I Technology*	-	0.000	0.000	1.927	-	1.927	1.968	2.101	2.208	2.208	0.000	10.412
AV5: *Protective Technologies*	-	0.000	6.800	7.692	-	7.692	7.839	6.443	6.515	6.580	0.000	41.869

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army												Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*							
AV6: *Airborne Engineering Support Technology*	-	0.000	0.882	0.899	-	0.899	0.917	0.935	0.946	0.946	0.000	5.525
AV7: *Atmospheric Modeling and Meterological Technology*	-	0.000	5.812	5.945	-	5.945	6.064	6.186	6.255	6.318	0.000	36.580
AV9: *Advanced PNT for GPS Independent Environments Tech*	-	0.000	6.974	6.656	-	6.656	10.357	8.735	8.833	8.834	0.000	50.389
AW1: *Autonomous Navigation Technology*	-	0.000	0.400	1.798	-	1.798	2.198	2.098	0.000	0.000	0.000	6.494
AW3: *DoD PNT M&S Collaborative Initiative (CI) Technolo*	-	0.000	2.000	1.998	-	1.998	0.000	0.000	0.000	0.000	0.000	3.998
AW5: *Modular GPS Independent Sensors Technology*	-	0.000	4.140	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.140
BP2: *Sensor and Electronic Network Initiatives (CA)*	-	0.000	23.500	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	23.500
BZ6: *Narrowband SATCOM Technology*	-	0.000	0.000	0.999	-	0.999	0.000	0.000	0.000	0.000	0.000	0.999
BZ8: *Aerial Teir Networking (High Altitude)*	-	0.000	0.000	0.400	-	0.400	0.400	1.399	4.854	3.654	0.000	10.707

*This project's R-2a exhibit has been suppressed due to funding not beginning until after FY 2021

Note

In Fiscal Year (FY) 2020 this Program Element (PE) was previously funded, with continuity of effort realigned from the following PEs:
* PE 0602120A Sensors and Electronic Survivability
* PE 0602270A Electronic Warfare Technology
* PE 0602705A Electronics and Electronic Devices
* PE 0602720A Environmental Quality Technology
* PE 0602782A Command, Control, Communications Technology
* PE 0602783A Computer and Software Technology
* PE 0602784A Military Engineering Technology

Exhibit R-2, **RDT&E Budget Item Justification:** PB 2021 Army	**Date:** February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*

A. Mission Description and Budget Item Justification

This PE investigates technologies, techniques, components and tools to provide an Army tactical network and enabling infrastructure that support operations in any environment, to include where the electromagnetic spectrum is denied or degraded. This is accomplished through the design, and development of technologies and components (e.g., electronic components, software and protocols) that provide unified transport and are supportable, mobile and survivable; assured and secure positioning, navigation, and timing in all environments; converged and coordinated cyber and electronic warfare activities; resilient mission command on the move; and the collection, processing, and dissemination of information for intelligence, surveillance, and reconnaissance. Commercial technologies are continuously investigated and leveraged where possible.

Work in this PE complements PE 0602782A (Command, Control, Communications Technology), PE 0602143A (Soldier Lethality Technology), PE 0602145A (Next Generation Combat Vehicle Technology), PE 0602146A (Network C3I Technology), PE 0602147A (Long Range Precision Fires Technology), PE 0602148A (Future Vertical Lift Technology), PE 0602150A (Air and Missile Defense Technology), PE 0602705A (Electronics and Electronic Devices), PE 0602709A (Night Vision Technology), PE 0602782A (Command, Control, Communications Technology), PE 0603008A (Command Electronic Warfare Advanced Technology), PE 0603710A (Night Vision Advanced Technologies), and PE 0603772A (Advanced Tactical Computer Science and Sensor Technology), PE 0603001A (Warfighter Advanced Technology), PE 0603118A (Soldier Lethal ty Advanced Technology), PE 0603462A (Next Generation Combat Vehicle Advanced Technology), PE 0603464A (Long Range Precision F res Advanced Technology), PE 0603465A (Future Vertical Lift Advanced Technology), PE 0603466A (Air and Missile Defense Advanced Technology), PE 0603463A Network C3I 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, the United States Army Space and Missile Defense Command and the Army Engineer Research and Development Center.

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	**Date:** February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*

B. Program Change Summary ($ in Millions)	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**
Previous President's Budget	0.000	114.516	133.431	-	133.431
Current President's Budget	0.000	138.016	114.404	-	114.404
Total Adjustments	0.000	23.500	-19.027	-	-19.027
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	23.500			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	-19.027	-	-19.027

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2019**	**FY 2020**
Project: BP2: *Sensor and Electronic Network Initiatives (CA)*		
Congressional Add: *Small Satellite Technology*	-	3.000
Congressional Add: *Radioisotope Power Systems*	-	2.500
Congressional Add: *Anti-Tamper Technology Development*	-	10.000
Congressional Add: *Next Generation Synthetic Aperture*	-	5.500
Congressional Add: *Sensing Technologies for Rapid Hazard Detection*	-	2.500
Congressional Add Subtotals for Project: BP2	-	23.500
Congressional Add Totals for all Projects	-	23.500

Change Summary Explanation

FY21 funds realigned to support Army Modernization Priorities and National Defense Strategy.

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AM6 / *Modular RF Communications Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AM6: *Modular RF Communications Technology*	-	0.000	3.909	3.810	-	3.810	0.000	0.000	10.082	12.173	0.000	29.974

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
PE 0602782A Command, Control, Communications Technology:
* Project H92 Communications Technology

A. Mission Description and Budget Item Justification

This Project investigates and develops techniques, methods, and standards for automation and intelligence to optimally broadcast data among available radio frequency (RF) and networking technologies. This Project adds resiliency to the network through diversity and automation techniques to make automated network decisions, (e.g., automated Primary, Alternate, Contingency, and Emergency (PACE)) for the tactical Army to maintain operation in continually changing environments.

Work in this Project complements PE 0603463A Network C3I Advanced Technology / Project AM7 (Modular RF Communications Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Modular Radio Frequency Communications Technology	-	3.731	3.810
Description: This effort investigates and develops techniques, methods, and standards for automation and intelligence to optimally route data among available radio frequency and networking technologies. This effort adds resiliency to the network through diversity and automation techniques to make automated network decisions, (e.g., automated PACE) for the tactical Army to maintain operation in continually changing environments.			
FY 2020 Plans: Investigate techniques and algorithms for autonomous network initialization, detection, and adaption; design and develop the architecture to enable validation of algorithms for network initialization from start-up condition; research multiple approaches to autonomous networking by providing algorithms to detect available networks and networking technologies; and develop specifications for shared interfaces between network technologies and autonomous networking algorithms.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AM6 / *Modular RF Communications Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will investigate techniques based on Artificial Intelligence (AI) and Machine Learning (ML) to sense anomalies and degradation due to contested and congested Radio Frequency (RF) environments, predict the cause based on trained ML models, and coordinate across the network to recommend successful mitigation actions/procedures; research applicability of these techniques in a distributed, resource constrained tactical edge where computing resources are limited, communication pipes are narrow, connectivity is intermittent, and power is restricted due to size and weight of the battery; and determine distributed computing techniques to process, reduce, and fuse data at the tactical edge enabling local actions and reduction in load on the bandwidth constrained, intermittently connected networks. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.178	-
Accomplishments/Planned Programs Subtotals	-	3.909	3.810

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AM8 / *Protected SATCOM Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AM8: *Protected SATCOM Technology*	-	0.000	9.600	4.995	-	4.995	1.499	0.000	6.576	8.971	0.000	31.641

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602782A Command, Control, Communications Technology:
* Project H92 Communications Technology

A. Mission Description and Budget Item Justification

This Project investigates resiliency of Wideband Satellite Communications (SATCOM) in contested and congested electromagnetic environments. Wideband SATCOM is the primary high-bandwidth Beyond Line of Sight (BLOS) Communications used by the tactical Army. This Project designs and develops technologies and components, such as interference cancellation, to increase availability and reliability of Wideband SATCOM in spectrum-challenged environments.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) / AM9 (Protected SATCOM Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Protected Satellite Communication Technology	-	9.164	4.995
Description: This effort designs and develops technologies and components to increase resiliency of Wideband SATCOM in contested and congested electromagnetic environments. This effort develops resiliency through science & technology investigation. ***FY 2020 Plans:*** Research to advance satellite communications technology in order to automatically adapt to constantly changing, congested, and contested environments; investigate emerging commercial aerial and overhead capabilities and products, to select those that may be leveraged for tactical Army use; conduct experiments to establish a baseline for future research of intelligent satellite communications (i.e., systems that automatically adapt and mitigate network problems); investigate technology to mature components that support the control of the Army satellite network in a contested environment; and research emerging			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AM8 / *Protected SATCOM Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
commercial Low Earth Orbit (LEO) satellite mega-constellations to select applicable technologies to utilize and build upon for use in a mounted/dismounted environment. ***FY 2021 Plans:*** Will develop satellite communications technology that automatically adapts to constantly changing, congested, and contested environments; conduct experiments to refine the baseline for future research of intelligent and diverse satellite communications (i.e., systems that automatically adapt and mitigate network problems); and investigate technology to mature components that support the control of the Army satellite networks in a contested environment. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This effort is transitioning to Program Element 0603463A Network C3I Advanced Technology, Project AM9 - Protected SATCOM Advanced Technology.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.436	-
Accomplishments/Planned Programs Subtotals	-	9.600	4.995

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AN3 / *Non Traditional Waveforms Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AN3: *Non Traditional Waveforms Technology*	-	0.000	3.291	0.000	-	0.000	0.000	4.691	7.804	4.683	0.000	20.469

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602782A Command, Control, Communications Technology:
* Project H92 Communications Technology

In FY21 this Project is being realigned to:
Program Element 0603463A Network C3I Advanced Technology:
* Project AP6 C4ISR Integrated Demonstrations Advanced Tech

A. Mission Description and Budget Item Justification

This Project investigates non-traditional protocols and technologies to provide spectrum efficiency, high bandwidth, lower spectrum footprint, or anti-jam capabilities to tactical networks. This Project develops network resiliency for the dismounted and vehicular units through science & technology investigation.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) / Project AN4 (Non Traditional Waveforms Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Non Traditional Waveforms Technology	-	3.142	-
Description: This effort investigates non-traditional protocols and technologies to provide spectrum efficiency, high bandwidth, lower spectrum footprint, anti-jam capabilities to tactical networks. This effort develops network resiliency for the dismounted and vehicular units through science & technology investigation.			
FY 2020 Plans: Develop novel beam-tracking techniques and advanced directional mobile ad-hoc networking (MANET) technology to support on-the-move (OTM) millimeter wave communications; conduct study of dynamic effects of vehicle and vehicle systems on communication systems, such as the impacts to highly directive systems and/or cooperative beamforming techniques; and			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AN3 / *Non Traditional Waveforms Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
design adaptive power control techniques and dismounted networking for improved low probability of intercept / low probability of detection (LPI/LPD) characteristics. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding in this effort is being realigned to PE 0603463A Network C3I Advanced Technology / Project AP6 C4ISR Integrated Demonstrations Advanced Tech.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.149	-
Accomplishments/Planned Programs Subtotals	-	3.291	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AN5 / *Protected SATCOM-WB Global SATCOM Inter Canc Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AN5: *Protected SATCOM-WB Global SATCOM Inter Canc Tech*	-	0.000	0.400	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.400

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602782A Command, Control, Communications Technology:
* Project H92 Communications Technology

In FY21, this Project is Eliminated.

A. Mission Description and Budget Item Justification

This Project develops interference cancellation technologies to allow uninterrupted and resilient communications over the Wideband Global Satellite constellation when operating in proximity to enemy threats.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) / Project AN6 (Prot SATCOM-WB Global SATCOM Interference Canc Adv Tech.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Protected Satellite Communication ? Wide Band Global Satellite Communication Interference Cancellation Technology ***Description:*** This effort develops interference cancellation technologies to allow uninterrupted and resilient communications over the Wideband Global Satellite constellation when operating in proximity to enemy threats. ***FY 2020 Plans:*** Validate the performance of interference cancelling technology to protect satellite communications; mature predictive algorithms for satellite-based interference cancelling technology to establish expected improvement of tactical terminal operation in the presence of Electronic Warfare (EW) threats or jammers. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Effort completes in FY2020.	-	0.382	-
Title: FY 2020 SBIR/STTR Transfer	-	0.018	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AN5 / *Protected SATCOM-WB Global SATCOM Inter Canc Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	-	0.400	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AN7 / *COE - Every Receiver is a Sensor Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AN7: *COE - Every Receiver is a Sensor Technology*	-	0.000	3.005	3.062	-	3.062	3.123	3.186	3.222	3.222	0.000	18.820

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602270A Electronic Warfare Technology:
* Project 906 Tactical Electronic Warfare Applied Research

A. Mission Description and Budget Item Justification

This Project investigates, designs, and codes advanced automated exploitation and fusion analysis tools, applications, and software services that harvest, correlate and fuse tactical receiver sources with new and emerging data sources to improve understanding of the threat picture and more efficiently support near-real time Situational Understanding of the battlefield.

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

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

Fiscal Year FY20 realignments were due to financial restructuring in support of Army Modernization Priorities.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Data Analytics for Situational Awareness	-	2.868	3.062
Description: This effort investigates and designs spectrum sensing, electronic sensing and intelligence collection technologies and analytics to enhance overall situational understanding within a contested battlespace. Efforts focus on developing the analytics necessary to taking advantage of the expanding number of data sources available by leveraging existing tactical receivers and other tactical data feeds.			
FY 2020 Plans: Investigate deep learning techniques to leverage tactical and national data sources identified in FY19 to improve the threat picture while reducing the analysts? burden in understanding of the Electromagnetic Operating Environment (EMOE); perform initial demonstrations with selected deep learning techniques and analytics to automatically generate an enemy Electronic Order of			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AN7 / *COE - Every Receiver is a Sensor Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Battle (EEOB); and demonstrate the capability to provide automated alerting and a fused picture of red cyber events to enhance the near-time Cyber Situational Understanding (SU) to support decision making. ***FY 2021 Plans:*** Will extend techniques to support fires and intelligence warfighting functions; develop target nomination mechanisms; and identify data to push forward to support the targeting process and inform Intelligence Preparation of the Battlefield and update enemy Common Operating Picture tools. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.137	-
Accomplishments/Planned Programs Subtotals	-	3.005	3.062

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AN9 / *UNT - Every Receiver is a Sensor Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AN9: *UNT - Every Receiver is a Sensor Technology*	-	0.000	3.850	1.998	-	1.998	2.038	2.079	2.103	2.103	0.000	14.171

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602782A Command, Control, Communications Technology:
* Project H92 Communications Technology

A. Mission Description and Budget Item Justification

This Project develops the algorithms to enable every communication receiver in the tactical environment to operate as a sensor while maintaining the systems' original networking capability. This Project matures standards and protocols to expand the Cyber-Electromagnetic Activity (CEMA) situational understanding.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) \ Project AO1 (UNT - Every Receiver is a Sensor Advanced Tech) and PE 0602146A (Network C3I Technology) \ Project AN7 COE - Every Receiver is a Sensor Technology.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Unified Network Technology (UNT) - Every Receiver is a Sensor Technology ***Description:*** This effort develops software algorithms to enable commercial communications transceivers to operate in the tactical environment as Beyond Line of Sight communications while maintaining the systems' original networking capability. ***FY 2020 Plans:*** Investigate multiple artificial intelligence/machine learning (AI/ML) techniques that are applicable to radio frequency (RF) domain; develop and test software algorithms for dynamic spectrum sensing that incorporate identified AI/ML techniques; and design and implement method and/or interface to transmit RF sensed metadata for use in intelligence. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This research effort was realigned to PE 0602146A (Network C3I Technology) / AM8 (Protected SATCOM Technology) in FY21 to support higher modernization priorities.	-	1.763	-
Title: Multi Intelligence Modernization Components and Architecture	-	1.913	1.998

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AN9 / *UNT - Every Receiver is a Sensor Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort investigates underlying architectures for dynamic resource management and technology underpinnings for advanced signal processing, exploitation, and novel sensor hardening to better understand our ability to detect, intercept, identify, and geo-locate radiated radio frequency (RF) energy to command our use of the electromagnetic spectrum while denying its use to our adversaries. ***FY 2020 Plans:*** Investigate and develop novel Electronic Warfare (EW) hardware technologies and techniques against adversarial Communication and Intelligence Surveillance and Reconnaissance (ISR) capabilities in the Electromagnetic Spectrum while in contested operational areas; and perform research to determine the feasibility of localized, distributed, and intermittent Electronic Warfare effects to support the Commander?s intent and conduct laboratory experiments utilizing developed EW techniques against high value threats to validate concepts. ***FY 2021 Plans:*** Will investigate dynamic resource management and technologies for advanced signal processing, conduct laboratory experiments of advanced multi-function capabilities exploiting RF emissions for adversaries; investigate high altitude, long range sensing to augment national surveillance assets bringing situational awareness and understanding to the tactical edge. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Reduction of total obligation authority.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.174	-
Accomplishments/Planned Programs Subtotals	-	3.850	1.998

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AN9 / *UNT - Every Receiver is a Sensor Technology*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AO2 / *Stand-In Advanced RF Effects (STARE)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AO2: *Stand-In Advanced RF Effects (STARE)*	-	0.000	7.504	4.383	-	4.383	2.051	2.111	2.134	2.134	0.000	20.317

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
Program Element (PE) 0602705A Electronics and Electronic Devices:
* Project EM8 High Power and Energy Component Technology
PE 0602782A Command, Control, Communications Technology:
* Project H92 Communications Technology
PE 0602270A Electronic Warfare Technology:
* Project 906 Tactical Electronic Warfare Applied Research

A. Mission Description and Budget Item Justification

This Project investigates distributed Electronic Warfare (EW) techniques for grey-zone operations and designs algorithms for sparse detection and EW, and investigates techniques for secure transmission across network transport links and designs networking communications with low probability of detection and intercept technologies.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) / Project AO3 (Robust Grey C3I Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: STAND-IN Advanced RF Effects (STARE)	-	1.886	1.998
Description: This effort investigates emerging technologies to enable EW applications in a grey environment. The goal is to develop software and reconfigurable radio frequency (RF) hardware in a low size, weight, and power form factor for distributed EW and communications.			
FY 2020 Plans: Investigate wideband reconfigurable transceivers, RF frontend hardware, reconfigurable filters, antenna tuners, and antennas for handheld and leave-behind EW applications; investigate techniques to counter adversarial surveillance and communications			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AO2 / *Stand-In Advanced RF Effects (STARE)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
and conduct laboratory experiments to determine effectiveness; and investigate techniques for identification and geolocation of advanced communications transceivers. ***FY 2021 Plans:*** Will investigate hardware limitations and mature component level technologies to improve stability within synchronized EW applications, this includes RF and signal processing hardware; research complex threat signal use cases with synchronized EW applications to determine additional limitations and further improvements for stability; and identify miniaturization strategies for motion- enabled reconfigurable circuits and tunable microelectromechanical systems components suitable for handheld, wide-bandwidth, adaptable EW applications. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Grey C3I Communications Technology ***Description:*** This effort investigates techniques for secure transmission across network transport links and designs networking communications with low probability of detection and intercept technologies. ***FY 2020 Plans:*** Investigate enhancements to commercial off-the-shelf technologies; mature components that contribute such as cellular and/or narrowband communications, to provide dismount and mounted operators with long-range connectivity in a hostile electromagnetic spectrum environment; and design and develop enhancements to improve network resiliency and robustness, such as low probability of detection, low probability of intercept, and/or anti-jam features. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** The funding in this effort was realigned to support higher priority modernization areas.	-	2.883	-
Title: Grey C3 Exploitation Technology ***Description:*** This effort investigates distributed EW techniques for grey-zone operations and designs algorithms for sparse detection and EW. ***FY 2020 Plans:*** Investigate and develop novel EW hardware technologies and techniques against adversarial Communication and Intelligence Surveillance and Reconnaissance (ISR) capabilities in the electromagnetic spectrum while in contested operational areas; and perform research to determine the feasibility of localized, distributed, and intermittent EW effects to support the Commander?s intent and conduct laboratory experiments utilizing developed EW techniques against signals of interest to validate concepts. ***FY 2021 Plans:***	-	2.394	2.385

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AO2 / *Stand-In Advanced RF Effects (STARE)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will design and develop precise synchronization hardware technologies for EW systems to significantly improve the effectiveness of countermeasures against adversarial threats; conduct experiments in laboratory environments to validate synchronization limitations; and validate initial countermeasures on distributed sources. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.341	-
Accomplishments/Planned Programs Subtotals	-	7.504	4.383

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army												Date: February 2020
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / *Network C3I Technology*				Project (Number/Name) AO4 / *Energy Efficient Devices Technology*			
COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AO4: *Energy Efficient Devices Technology*	-	0.000	5.412	5.473	-	5.473	5.838	5.410	5.470	5.525	0.000	33.128

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602705 Electronics and Electronic Devices:
* Project H94 Elect & Electronic Dev

A. Mission Description and Budget Item Justification

This Project addresses sustainment operations by unburdening the Soldier and reducing logistics requirements (e.g., fewer batteries) for communications, computing, and sensing. The objective is to improve the underlying energy efficiency of supply and demand for Soldier-portable and distributed sensor electronics to enable the dismounted Soldier to maintain communications, freedom of movement, and increase mission duration. The majority of the electronics power used by the dismounted Soldier and by distributed electronics is attributable to radio frequency (RF) communications. In addition, freedom of movement and action during sustained and high tempo operations requires seamless battery recharging. To address these challenges, energy efficient electronics research includes RF and optoelectronic circuits, devices, materials and wireless power (and data) transfer.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Energy Efficient Electronic and Photonic Components	-	5.166	5.473
Description: This effort investigates energy efficiency improvements in support of four key areas: RF component devices, optoelectronic devices for alternative communications modes, long-lived and high efficiency power sources, and efficient wireless power and data transfer technologies. These components enable energy-efficient communications and networked energy, specifically leading to increased soldier mission duration and long-lived networked electronics.			
FY 2020 Plans: Research and develop RF component technologies such as advanced silicon accelerators to improve squad level communication efficiency; develop zero-power sensors for wake-up radio applications; explore the development of optoelectronic devices for alternative communications; develop technologies for long-lived efficient power sources; develop efficient wireless power and data			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AO4 / *Energy Efficient Devices Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
technologies with >10% efficiency enabling squad-level power and data transfer; and explore methods to support higher rate and energy density wireless battery recharging. ***FY 2021 Plans:*** Will investigate and optimize the interplay between insulator materials to determine if transistor action provides significant power savings as theoretically predicted; investigate radiation tolerance of wide-band-gap semiconductors and compare to material dependent displacement energy, atomic number, bond strength, and lattice constant; develop optimized energy conversion semiconductor structures delivering 1mW power; understand and develop new materials for fast charge anodes with the objective to develop a material that can be scaled; explore chemistries to support fast charge batteries and investigate new electrolytes and additives to stabilize lithium plated on graphite; and study and develop RF component technologies, such as high efficiency materials, circuits, and neural network hardware for improved squad level communication efficiency. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.246	-
Accomplishments/Planned Programs Subtotals	-	5.412	5.473

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AO5 / *Tag Track and Locate Small Satellites Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AO5: *Tag Track and Locate Small Satellites Technology*	-	0.000	4.406	3.834	-	3.834	3.764	3.884	3.926	3.965	0.000	23.779

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602120A Sensors and Electronic Survivability:
* Project TS1 Tactical Space Research

A. Mission Description and Budget Item Justification

Tag, Track, and Locate Small Satellites Technology develops and adapts technologies for space-based and high altitude applications for Army tactical ground forces. Efforts include the design and development of sensors and electronic components for communications, signal and information processing, target acquisition, position/navigation, and threat warning within space and high altitude environments. Evaluations conducted leverage other Department of Defense (DoD) space science and technology applications to support Army space force enhancement and cooperative satellite payload development. Funds research in quantum sciences based communications, sensing, and data teleportation to mature current technologies for small spacecraft applications.

Work complements PE 0603463A (Network C3I Advanced Technology) / AO6 (Tag Track and Locate Small Satellites Adv Tech).

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

Work in this Project is performed by the United States Army Space and Missile Defense Command (USASMDC) in Huntsville, AL.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Tag Track and Locate Small Satellites	-	3.179	2.663
Description: This effort will design, develop, and adapt space-based technologies, components, and tools that lead to smaller, lighter, more responsive payloads and applications. These technologies allow for the rapid integration and development of tactical payloads in support of responsive space environments.			
FY 2020 Plans: Research and validate software, hardware, and algorithms used to enable space-based capabilities in support of the Army?s Modernization Priorities; investigate the maturity and feasibility of commercial advances and opportunities in small satellite constellation and payload management for application to future Army concepts.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AO5 / *Tag Track and Locate Small Satellites Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will validate payload technologies for small spacecraft to provide tactical land component forces with space capabilities for force projection and maneuver during Multi-Domain Operations; design and conduct experiments focused on terrestrial open air Quantum Entanglement Data Teleportation (QEDT) and space-to-ground QEDT; and qualify and implement Quantum Key Distribution (QKD) components in order to validate satellite-to-satellite crosslink QKD. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Space Components and Systems Assessment Technology ***Description:*** This effort supports experimentation and validation of hardware and software components and models to further anchor laboratory capabilities enabling small spacecraft and payload design and development. ***FY 2020 Plans:*** Design and conduct experiments for space-based technologies; and validate hardware and software components and models, to further anchor laboratory capabilities enabling small spacecraft and payload design and development. ***FY 2021 Plans:*** Will design and develop payload technologies for small spacecraft to provide tactical land component forces with space capabilities for force projection and maneuver during Multi-Domain Operations. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	1.073	1.171
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.154	-
Accomplishments/Planned Programs Subtotals	-	4.406	3.834

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AO5 / *Tag Track and Locate Small Satellites Technology*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AP4 / *CEMA Camouflage Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AP4: *CEMA Camouflage Technology*	-	0.000	9.716	9.841	-	9.841	10.116	9.967	9.809	9.907	0.000	59.356

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602705A Electronics and Electronic Devices Project:
* Project EM8 High Power and Energy Component Technology

A. Mission Description and Budget Item Justification

This Project develops and characterizes hardware and software to enable electronic spoofing and cyber deception along with inconspicuous Cyber Electromagnetic Activity (CEMA) and network operations of Army platforms and dismounts, while maintaining freedom to maneuver, communicate, and sense. This research is critical to counter near-peer ability to geo-locate our troops and put indirect fires onto our positions. This effort develops a holistic cross-domain analysis and assessment methodology for network and communication technologies faced with advanced CEMA. These investigations are critical to identifying vulnerabilities of United States systems and technologies so that network and network-enabled systems can be hardened as early in development as possible.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: RF/Cyber Sensing and Deception	-	0.382	3.159
Description: This effort develops technologies to avoid geolocation of blue force Radio Frequency (RF) emissions by peer/near-peer adversaries. Research will focus on developing low probability of detection (LPD) communications and decoys to increase freedom of maneuver while maintaining effective communications.			
FY 2020 Plans: Investigate compact antennas utilizing novel additive manufactured techniques to demonstrate wide bandwidth spectrum tuning for enabling low probability of detection communications in non-military bands; conduct experiments on passive optical-phased array (OPA) communication link based on chip-level, photonic integrated circuits; mature components for development of an active OPA for communication link studies; and investigate wideband reconfigurable transceivers, radio frequency frontend hardware, and antennas for decoy development.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AP4 / *CEMA Camouflage Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will develop hardware for RF decoys, including compact antennas, wideband reconfigurable transceivers, and radio frequency frontend hardware; model performance of coherent beam-forming from dispersed emitters for RF decoys; investigate techniques for decoy emission waveforms and antennas for decoy development; investigate materials, device designs, and components for non-RF communication techniques; demonstrate initial chip-level active optical-phased array (OPA) for communication link using co-packaged external laser; conduct experimentation on native photonic integrated circuit (PIC) laser and co-packaging control electronics. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funds realigned from other efforts within this Project to support increased focus on RF/Cyber Sensing and Deception.			
Title: Dynamic Intelligent Networks and Cyber Camouflage and Decoy for CEMA ***Description:*** This effort investigates techniques and develops methods for combining the physical (RF) and network (cyber) layers for enhanced effects when coupled with electromagnetic camouflage and decoy methods. ***FY 2020 Plans:*** Design and develop flexible and adaptive methods for automated/semi-automated active tactical cyber defense that use machine learning techniques to anticipate future activities and select the most effective response; design adaptive networking methods that leverage unconventional communication channels (e.g., lower-radio-frequencies and ultraviolet frequencies) and dynamic spectrum sensing to provide for enhancement, adaptation, and/or balancing of energy usage, probability of detection, jamming resistance, and security; implement networking protocols in simulation and/or hardware; and conduct experiments to develop and characterize the performance of such active cyber defense methods. ***FY 2021 Plans:*** Will implement and experimentally validate the use of unconventional spectrum, directional networking, and novel modulations to enhance the low-probability-of-detection features of the network; develop and characterize protocols for adapting networks to optimize performance under low-probability-of-detection constraints; and research adaptive cyber deception methodologies to provide defensive advantage by hiding mission critical assets (camouflage), misrepresenting a system (obfuscation), and luring the enemy to expend resources on fake nodes (decoys), while real systems remain safe and continue to execute mission critical tasks. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funds decreased to support increased focus on RF/Cyber Sensing and Deception.	-	3.308	2.398
Title: Understanding, Protecting, and Enabling CEMA Effects ***Description:*** This effort develops and continually improves methodology and approaches for estimating and predicting Cyber Electromagnetic Activity (CEMA) effects on networks and network-enabled systems during complex multi-domain operations when significant cross-domain effects can be expected. Methods include drawing upon past research concerning the interaction of cyber	-	3.080	2.207

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AP4 / *CEMA Camouflage Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
and electromagnetic threats on operational networks; anechoic chamber, laboratory, and field measurements; and first principles Modeling and Simulation (M&S) and engineering analysis. Abstracting, generalizing, and automating multi-domain CEMA operations will enable the development of analysis and assessment capabilities to anticipate the impact of future threats. Live, virtual, and simulated environments will be developed to estimate the potential operational impact of threat CEMA technologies on friendly systems. ***FY 2020 Plans:*** Develop techniques to estimate the effect of cyber and electromagnetic activities across functional layers (i.e., physical, electromagnetic, cyber, human, and operational); and study intelligent protocol learning and adaptation, automated vulnerability assessment techniques, physical-layer cyber assessment methodologies, and modeling and simulation representation of CEMA-enabled tactical scenarios. ***FY 2021 Plans:*** Will develop and extend techniques to estimate the effect of cyber and electromagnetic activities across all functional layers (i.e., physical, electromagnetic, cyber, human, and operational); mature investigations and enhance scientific understanding of cross-domain synergies building upon those previously discovered; and validate tools for understanding cross-domain synergies and determine region of applicability before the tools are passed on to vulnerability analysts. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funds decreased to support increased focus on RF/Cyber Sensing and Deception.			
Title: Vulnerability Analysis Methodology for CEMA Threats ***Description:*** This effort investigates threat/target interactions to develop experimental and analytical methodology for separate and cross-domain cyber and electromagnetic threat attack so that assessed vulnerabilities in a multi-domain complex environment can be reduced or eliminated before fielding new networks and network-enabled systems. Experimental and analysis methodology will be developed to investigate vulnerabilities of specific configurations of complex future networks with multiple communications modalities, advanced decoy techniques in the cyber and electromagnetic areas, and advanced Positioning, Navigation, and Timing (PNT) systems. ***FY 2020 Plans:*** Study multi-domain impact analysis and experimental techniques that encompass cyber, electronic warfare, and other electromagnetic activities; investigate novel communications modalities and techniques (e.g., ultraviolet, millimeter wave, situational adaptive controllers) to develop experimental and analytical methodologies to assess and discover vulnerabilities; and research new vulnerability assessment methodology and techniques for new, non-Global Positioning System (GPS) PNT technologies (e.g., inertial navigation technology, chip-scale atomic clocks, optical time transfer, and video-based technologies). ***FY 2021 Plans:***	-	2.505	2.077

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AP4 / *CEMA Camouflage Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will investigate cross-domain vulnerability analysis with both simulation and experimental techniques that encompass cyber, electronic warfare, and other electromagnetic activities; cross-domain experiments will include hacking communications equipment at all relevant levels of hacker sophistication while that equipment is under Electronic Warfare (EW) attack in controlled (i.e. anechoic chamber) environment for tactically plausible waveforms, power levels, switching algorithms, etc; validate analysis techniques previously developed for novel communications modalities and techniques (e.g., ultraviolet, millimeter wave, situational adaptive controllers) and develop new experimental and analytical methodologies to assess and discover vulnerabilities; and research new vulnerability assessment methodology and techniques for new, non-Global Positioning System (GPS) PNT technologies (e.g., inertial navigation technology, chip-scale atomic clocks, optical time transfer, and video-based technologies). ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funds decreased to support increased focus on RF/Cyber Sensing and Deception.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.441	-
Accomplishments/Planned Programs Subtotals	-	9.716	9.841

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AP5 / *Electronic Warfare Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AP5: *Electronic Warfare Technology*	-	0.000	2.823	2.915	-	2.915	3.012	3.084	3.125	3.156	0.000	18.115

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602120A Sensors and Electronic Survivability:
* Project H16 S3I Technology
PE 0602705A Electronics and Electronic Devices
* Project EM8 High Power and Energy Component Technology:

A. Mission Description and Budget Item Justification

This Project investigates emerging technologies related to electronic warfare (EW) applications, non-kinetic survivability/lethality, and emerging concepts of operation in the increasingly contested and congested electromagnetic environment, with the goal of enhancing the survivability/lethality of Army platforms through electronic attack (EA), electronic warfare support (ES), and electronic protection (EP).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Electronic Warfare Technology Research	-	2.116	2.260
Description: This effort investigates emerging technologies related to EW applications, non-kinetic survivability/lethality, and emerging concepts of operation in the increasingly contested and congested electromagnetic environment, with the goal of enhancing the survivability/lethality of Army platforms through EA, ES, and EP.			
FY 2020 Plans: Investigate algorithms for emitter geolocation and classification from distributed radio frequency (RF) receivers; research, design and develop spectrum sensing and channel prediction signal processing techniques to anticipate adversarial operations in congested and contested electromagnetic environments; develop EA and EP techniques in an advanced hardware-in-the-loop complex electromagnetic environment to investigate deception and degradation of realistic threat capabilities; investigate methods to detect and identify threat emitters without a priori characterizations; and investigate techniques to determine target susceptibility to EA using feedback from ES sensors.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AP5 / *Electronic Warfare Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will investigate signal processing techniques for detection, classification, and emitter geolocation from distributed radio frequency (RF) receivers; develop electronic attack and electronic protection techniques in an advanced hardware-in-the-loop electromagnetic environment by adding situational awareness sensor input into the cognitive RF algorithm to investigate deception and degradation of realistic threat capabilities; investigate techniques to identify and classify RF emitters based on generalized attributes and characteristics; develop hardware-in-the-loop resource manager to expand RF channel emulation; study cognitive EW integration into the hardware-in-the-loop laboratory environment; and develop approaches for radar and communications networks to co-exist in congested and contested electromagnetic environments. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Electronic Warfare Assessment Technologies ***Description:*** This research investigates emerging technologies related to EW applications (e.g., digital RF memory, software defined radios, cognitive radars) and electromagnetic-enabled cyberspace operations in the increasingly contested and congested environment. Research is focused on near-peer and future threats to enhance survivability/lethality, and discover critical vulnerabilities, of Army technologies and systems through cyber and electromagnetic activities (CEMA). ***FY 2020 Plans:*** Study novel electronic warfare approaches using unmanned aerial systems, software defined radios, and digital RF memory, and cyber techniques. These multi-domain technologies will be studied in advanced CEMA laboratories and anechoic chambers to develop approaches and methodology to assess technologies and systems. RF to digital signal conversion methodologies will be studied along with traffic-based modeling to reverse engineer protocols and automated digital vulnerability techniques. ***FY 2021 Plans:*** Will continue to investigate novel EW approaches using unmanned aerial systems, software defined radios, digital RF memory, and cyber injection techniques; continue to investigate multi-domain technologies in advanced CEMA laboratories, anechoic chambers, field experiments, and with modeling and simulation so as to develop approaches and methodologies to assess friendly and enemy technologies and systems. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	0.578	0.655
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:***	-	0.129	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AP5 / *Electronic Warfare Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Funding transferred in accordance with Title 15 USC ?638			
FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	-	2.823	2.915

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AP7 / *Comms/Horiz Int for Army Mod Priorities Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AP7: *Comms/Horiz Int for Army Mod Priorities Tech*	-	0.000	0.500	2.914	-	2.914	2.615	2.964	3.028	3.051	0.000	15.072

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602782A Command, Control, Communications Technology:
* Project H92 Communications Technology

A. Mission Description and Budget Item Justification

This Project investigates the communication architectures of each of the Army's modernization priorities and determines technologies and components to enable assured and resilient communications and horizontal integration.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) / Project AP8 (Comms Supp to CSA/Horizontal Int Fields Adv Tech)

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Communications Support to Army Modernization Priorities / Horizontal Integration Fields Technology	-	0.477	2.914
Description: This project investigates the communication architectures of each of the Army?s modernization priorities and determines technologies and components to enable assured and resilient communications. ***FY 2020 Plans:*** Design and develop network requirements for Long Range Precision Fires (LRPF), Next Generation Combat Vehicle (NGCV), Future Vertical Lift (FVL), Air & Missile Defense (AMD), and Soldier Lethality (SL) Cross-Functional Teams (CFTs) based upon extended or new operational capabilities, and future science & technology insertions. ***FY 2021 Plans:*** Will develop lab-based integration of the many varied technologies participating in the NGCV-themed NetModX21 and an Integrated Visual Augmentation System capstone investigation as risk reduction activities; and conduct end-to-end system of			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AP7 / *Comms/Horiz Int for Army Mod Priorities Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
systems modeling and simulation of varied technologies that are planned to participate in the Integrated Tactical Network-themed NetModX22 as early risk reduction activities. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increased to support NetModX21 activities.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.023	-
Accomplishments/Planned Programs Subtotals	-	0.500	2.914

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AQ2 / *EW Techniques Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AQ2: *EW Techniques Technology*	-	0.000	0.000	0.500	-	0.500	0.500	0.520	0.525	0.525	0.000	2.570

Note

This is a new start in FY2021.

This Project is a New Start for Fiscal Year 2021 (FY21).

A. Mission Description and Budget Item Justification

This Project develops countermeasures against adversarial counter-fire systems that obscure and create distractive blue force locations

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

Work in this Project is performed by the U.S. Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Simultaneous CM for Active Reconnaissance and Surveillance (SCARS) ***Description:*** This effort will provide investments in Electronic Warfare (EW), against advancing counter-fire sensors. Research will be performed to investigate highly synchronized systems capabilities to achieve advanced effects. ***FY 2021 Plans:*** Will conduct initial investigations and experiments against modeled or representative threats to validate technical approach feasibility for advanced EW effects. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** New Project to investigate applied research of Electronic Warfare Techniques.	-	-	0.500
Accomplishments/Planned Programs Subtotals	-	-	0.500

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AQ7 / *High Tempo Data Driven Decision Tools Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AQ7: *High Tempo Data Driven Decision Tools Technology*	-	0.000	0.000	2.804	-	2.804	0.000	0.000	0.000	0.000	0.000	2.804

Note

This Project is a New Start for Fiscal Year 2021 (FY21).

A. Mission Description and Budget Item Justification

This Project investigates and develops data driven decision tools that help develop cyber Situational Understanding (SU) for commanders and staff that will enable them to more quickly and accurately assess and integrate cyber impacts with all of the domains in Multi-Domain Operations (MDO) and to thereby enhance mission effectiveness by improving decision cycles.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) / Project AQ8 (High Tempo Data Driven Decision Tools Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: High Tempo Data Driven Decision Tools ***Description:*** Develops data driven decision tools that help develop cyber Situational Understanding (SU) for commanders and staff that will enable them to more quickly and accurately assess and integrate cyber impacts with all of the domains in Multi-Domain Operations (MDO) and to thereby enhance mission effectiveness by improving decision cycles. ***FY 2021 Plans:*** Will investigate methods for improving Common Operating Picture (COP) decision time and quality; design visualizations for the exploration and understanding of the impact of the cyber domain on the current mission in order to improve the decision cycles. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This is a New Start Project for FY21.	-	-	2.804
Accomplishments/Planned Programs Subtotals	-	-	2.804

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AQ7 / *High Tempo Data Driven Decision Tools Technology*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AQ9 / *Expeditionary Data to Decisions Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AQ9: *Expeditionary Data to Decisions Technology*	-	0.000	2.000	2.805	-	2.805	4.999	3.287	3.289	0.591	0.000	16.971

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602782A Command, Control and Communications Technology:
* Project 779 Command, Control and Platform Electronics Tech

A. Mission Description and Budget Item Justification

This Project investigates, codes and designs software, and algorithms that improve Mission Command by increasing situational understanding, via the intelligent sharing of data in degraded networks during high op-tempo missions or while under cyber-attack. This Project includes researching artificial intelligence techniques to improve decision making capacity across the battlefield by using software knowledge representation to model the mission, automate staff tasks, correlate and analyze information, and provide recommendations. These capabilities allow forces to maximize op-tempo and maintain strategic advantage.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Expeditionary Data to Decisions Technology	-	1.909	-
Description: This effort investigates algorithms and software that dynamically identify and arrange the most accurate, useful, and timely information from across the warfighting network to optimize commander and staff decision cycles and enable Mission Command from anywhere on the battlefield. It matures artificial intelligence techniques that provide the most relevant and available data to support time-sensitive and critical decisions, and present information in context and in alignment with complex cognitive needs.			
FY 2020 Plans: Will identify a set of critical, time-constrained decisions that require data and information collection and analysis, map battlespace data and information to a set of important tactical decisions and identify the appropriate models for those decisions; and develop a set of initial requirements to enable the development a concept demonstrator upon effort completion.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AQ9 / *Expeditionary Data to Decisions Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Planned program decrease to support other efforts in this Project.			
Title: Mission Command Technologies ***Description:*** This effort investigates and designs components and technologies for agile, survivable, modular, non-traditional Command Post platforms to enable decentralized and distributed mission command operations in the future operating environment. ***FY 2021 Plans:*** Will identify a set of critical, time-constrained decisions that require data and information collection and analysis, map battlespace data and information to a set of important tactical decisions and identify the appropriate models for those decisions; and develop a set of initial requirements for a concept demonstrator; conduct experiments on Command Post components for secure communications within a decentralized environment to validate component performance; and provide knowledge products that support development of future requirements. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Realigned from PE 0602143A Soldier Lethality Technology / Project BE1 Support Technology for Mission Command.	-	-	0.905
Title: Camouflage, Concealment and Decoys ***Description:*** This effort matures innovative camouflage, concealment and deception technologies for expeditionary high-value assets to defeat advanced current and emerging adversary Intelligence, Surveillance and Reconnaissance (ISR) threats, and to reduce the probability of detection in multi-domain operations. Matures physics-based models for material and system performance that support probability of detection metrics in the multi-domain operational environment, assisting in closing the capability gap between current camouflage, concealment and deception technologies and defeating enemy sensorial capabilities in future operating environments. ***FY 2021 Plans:*** Will research performance of camouflage materials to identify promising solutions for Command Post survivability; research and evaluate performance effects of new materials against emerging threats; research hyperspectral and LIDAR sensor defeat approaches; and evaluate candidate deception solutions. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Realigned from PE 0602143A Soldier Lethality Technology / Project AZ9 Soldier Protection Adv Tech Detectability.	-	-	1.900
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638	-	0.091	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AQ9 / *Expeditionary Data to Decisions Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	-	2.000	2.805

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AR1 / *Robust, Resilient and Intelligent C3I Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AR1: *Robust, Resilient and Intelligent C3I Technology*	-	0.000	8.700	13.775	-	13.775	14.035	14.316	14.476	14.622	0.000	79.924

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602120A Sensors and Electronic Survivability:
* Project H16 S3I Technology
PE 0602783A Computer and Software Technology:
* Project Y10 Computer/Info Sci Tech

A. Mission Description and Budget Item Justification

This Project develops and characterizes machine learning and artificial intelligence methods for processing, analysis and provisioning control of smart, distributed, networked sensors and devices. It provides situational understanding and decision support to enable fast, adaptive and interoperable C3I network-integrated applications, resilient to adversarial activity in contested and complex environments. Effective use of distributed networked sensors, autonomous agents and automated decision support tools is critical to address threats posed by peer competitors and more capable asymmetric forces, particularly in complex environments where traditional sensors provide an incomplete understanding of the tactical situation due to adversarial activity, occluded sightlines and small fields of regard.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Intelligent Signal and Image Analytics for C3I	-	6.213	6.460
Description: This effort designs and characterizes technologies for multi-modal (acoustic, seismic, infrasound, electric and magnetic (E/H) field, and passive radio frequency (RF), low-cost networked sensors to enhance persistent sensing capabilities for increased probability of target detection and reduced false alarms. These combined sensors have unique capabilities that enable detection of electrical equipment operation, underground facilities, vehicles, weapons launch, gunfire, and explosions. The work includes development of artificial intelligence (AI) and machine learning (ML) for analytics to improve situational understanding.			
FY 2020 Plans: Develop very low-frequency electric- and magnetic-field sensors and arrays for electromagnetic imaging, and for power anomalies; improve hardware and software reliability for novel low-size, weight, power and cost (SWAP-C) unattended sensor applications; develop multi-functional algorithms with acoustic and seismic fusion and robust noise mitigation to detect and			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AR1 / *Robust, Resilient and Intelligent C3I Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
track diverse targets in complex environments; enhance elevation localization accuracy for Counter-Unmanned Aerial Vehicle (C-UAV) and counter-sniper applications; develop AI-enabled analytics for situational understanding, improved performance characterization, data enrichment, and domain adaptation; create synthetic data for training and algorithm development purposes; evaluate deep learning algorithms against adversarial attacks; assess and compare performance and confidence using curated multi-modal data and tools; and compare domain adaptation methods using automatically curated re-training data with off-ramp to fielded capabilities. ***FY 2021 Plans:*** Will assess improved 3-D electric and magnetic-field sensors for electromagnetic imaging, target characterization, electric power analysis for fault detection, resilient supervisory control and data acquisition, and anomaly detection; improve ?processing at the edge? hardware and software reliability for novel low-size, weight, power and cost (SWaP-C) unattended sensor applications and assured Position, Navigation, and Time (PNT) applications; develop multi-functional algorithms to encompass multimodal sensors to detect targets in complex tactical scenarios; investigate the use of electric and magnetic field sensing arrays and inversion methods for new classes of extremely low frequency imager development; develop infrasound through audible frequency sensors, algorithmic and hardware solutions to automate the detection, tracking, and localization of transient and continuous-wave targets; incorporate advanced seismic sensing for enhanced detection and localization of ground targets; exploit coupled acoustic and seismic sensing to automatically differentiate and track ground and airborne targets. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Increase in funding to support sensor assessments that directly impact the Network/C3I modernization priority goals.			
Title: Smart Networks and Distributed Sensing for C3I ***Description:*** This effort will develop and assess a concept to link physical sensors and information sources to Soldiers and small units. Specifically, the research focuses on (1) multi-modal sensor fusion for detection and classification of human activities and infrastructures such as personnel, vehicles, machinery, RF emissions, chemicals, and computers in hidden and confined spaces, (2) interoperability and networking of disparate sensors and information sources, (3) distributed information for decision-making, and (4) approaches for fusing results of processed outputs of multi-modal sensors, such as visible, infrared (IR), and hyperspectral imagers, and acoustic, magnetic, and electric field sensors. ***FY 2020 Plans:*** Develop the framework for a reconfigurable network of fixed and relocatable sensors for accurate detection and tracking of hostile forces and in support of reconnaissance activities. ***FY 2021 Plans:***	-	0.280	5.337

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AR1 / *Robust, Resilient and Intelligent C3I Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Develop the framework for a reconfigurable network of fixed and re-locatable sensors for accurate detection and tracking of hostile forces and in support of reconnaissance activities. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Planned program increase to fund higher priority improvements for a reconfigurable network of sensors.			
Title: Information Processing and Analysis ***Description:*** This effort investigates techniques that integrate local and external information sources and applies machine learning and artificial reasoning approaches to support automated intelligence analysis, command/control, and decision making. The goal is to enable tactical users to cooperatively interact with relevant and timely tactical information supported by methods that are network-aware/adaptive and deliver transparent and uniform transport. ***FY 2020 Plans:*** Develop and evaluate methods for multi-modal, network-aware, ensemble machine learning and computational reasoning that enable tactical human and autonomous decision-making where there may be few or no guarantees of convergence and are amenable to adaptive learning and optimization; and develop algorithms and approaches for self (e.g., self-organizing, self-managing, self-adapting, self-maintaining/self-protecting, etc.) behaviors in heterogeneous, command and control complex-systems that facilitate interoperability, just-in-time human interactions, and that implement resilient mission command network and decision making functionality. ***FY 2021 Plans:*** Will investigate and develop resilient information mediation and accelerated tactical and intelligence decision making tools through the use of virtualization and machine learning-augmented autonomous algorithms; develop intelligent Information Mediation and Immersive Common Operating Picture (COP) by applying resilient network protocols for adaptive information mediation; develop and assess prototype contextual policy-based and continuously learned information recommendation integrating Value-of-Information (VoI)/Quality-of-Information (QoI) network sensitivity; and integrate real-time multi-sensor and multi-domain battlefield information for accelerated exploration and decision making in an immersive COP that is tailorable and learns Soldier preferences. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	1.812	1.978
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:***	-	0.395	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AR1 / *Robust, Resilient and Intelligent C3I Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Funding transferred in accordance with Title 15 USC ?638			
FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	-	8.700	13.775

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AR3 / *Intelligent Environmental Battlefield Awareness*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AR3: *Intelligent Environmental Battlefield Awareness*	-	0.000	0.000	3.007	-	3.007	3.097	3.070	2.133	0.000	0.000	11.307

Note

In Fiscal Year 2021 (FY21), this Project is a Restructure.

This Project had a Skip Year for funding for FY20 but was funded in FY19 in Program Element 0602720A:
* Project 835 Mil Med Environ Crit
* Project 896 Base Fac Environ Qual.

A. Mission Description and Budget Item Justification

This Project investigates, develops, and designs technologies to allow Soldiers to maneuver faster in dynamic environments as informed by physical, geological, and biological constraints. This Project enhances visualization tools for mission planning through delivering web modules/software tools which contain crucial geo-chemical resources and advanced knowledge of geo-environmental infrastructure for mission planners. This Project supports the Common Operating Environment LOE. Research in this Project will transition to PE 0603463A (Network C3I Advanced Technology) / Project AR4 Intelligent Env Battlefield Awareness Adv Tech.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy. Work in this Project is performed by the United States Army Engineer Research and Development Center and coordinated with the United States Army Futures Command.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Arctic Threat ***Description:*** This effort delivers a geospatial decision aid to United States Army units conducting expeditionary operations to anticipate threats, hazards and dependencies posed by terrain and weather extremes in cold regions. ***FY 2021 Plans:*** Will fund research to ensure high fidelity understanding of terrain conditions for improved threat (e.g., thaw vulnerability and ground state instability) and hazard (e.g., chem/bio fate and effects and pathogenicity) prediction to aid in preventing risks to operational effectiveness and efficiency in cold regions. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This Project had a Skip Year for funding for FY20 but was funded in FY19 in Program Element 0602720A, Project 835 Mil Med Environ Crit and Project 896 Base Fac Environ Qual.	-	-	1.497
Title: Geo-Forensics	-	-	0.700

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AR3 / *Intelligent Environmental Battlefield Awareness*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort generates data to develop the data mining framework and software tools to generate geo-referenced predictive map layers to inform mission planning and operational assessments for area denied sites. ***FY 2021 Plans:*** Will develop preliminary framework by coalescing existing geo-forensic methodologies into a geochemical forensics tool that represent a high resolution geo-referenced soil type map layer of a specified Outside Continental United States (OCONUS) areas of interest, powered by soil-matching algorithms. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This Project had a Skip Year for funding for FY20 but was funded in FY19 in Program Element 0602720A, Project 835 Mil Med Environ Crit and Project 896 Base Fac Environ Qual.			
Title: Predictive Geographic Information System (GIS) Mapping (physical) ***Description:*** This effort develops a comprehensive GIS tool that integrates predictive models of soil, vegetation, hydrology, and permafrost conditions in OCONUS dark sites from the statistical analysis of known datasets and the application of geophysical principles. ***FY 2021 Plans:*** Will design a unified framework that will integrate several independently derived geospatial tools with streamlined data analysis and mitigation of statistical errors. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This Project had a Skip Year for funding for FY20 but was funded in FY19 in Program Element 0602720A, Project 835 Mil Med Environ Crit and Project 896 Base Fac Environ Qual.	-	-	0.810
Accomplishments/Planned Programs Subtotals	-	-	3.007

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AR5 / *Understanding the Environment as a Threat Technolo*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AR5: *Understanding the Environment as a Threat Technolo*	-	0.000	3.943	2.331	-	2.331	1.980	1.284	0.980	0.990	0.000	11.508

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602720A Environmental Quality Technology
* Project 835 Mil Med Environ Crit
* Project 896 Base Fac Environ Qual

A. Mission Description and Budget Item Justification

This Project designs and advances mission planning software enabling the Solider to identify, track, and plan for industrial or commercial chemical/environmental threats. Software modules will increase capability of mission based planning technologies providing new operational routing options for mission execution with environmental threat overlays. Work supports the Common Operating Environment research effort. Research in this Project will transition to PE 0603463A (Network C3I Advanced Technology) / Project AR6 Understanding the Environment as a Threat Adv Tech.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Environmental Threat Overlays for Operational Routing/Predictions of Lethal Environments	-	2.327	-
Description: This effort develops tools enhancing operational route planning technologies. It will deliver a new capability informing the Solider of the risks associated with physical landscape, chemical exposure, and biological threats lethal to personnel and disruptive to equipment. Tools will support route planning and soldier mobility within a complex urban environment.			
FY 2020 Plans: Develop models and algorithms needed for software to define potential hazards and the affects to Solider mobility. Software will model chemical and biological threats associated with Outside Continental United States (OCONUS) soil and landscape behavior within an urbanized operational environment. Relevant urban chemical and biological risk information will inform models.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AR5 / *Understanding the Environment as a Threat Technolo*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Effort completes in FY 2020.			
Title: Predictions of Lethal Environments/ Computational Prediction of Threats in the Operational Environment ***Description:*** This effort develops tools and models for the Soldier providing critical information of the operational environment allowing the Soldier to operate in, avoid, or prepare for contaminated battlefields. ***FY 2020 Plans:*** Conduct research to provide new computational predictions that inform the Soldier on how materials interact with, move, and change in the operational environment and how to respond to contaminated battlefields. ***FY 2021 Plans:*** Will conduct research to design software modules that support mission based planning technologies for improved operational maneuver routing (e.g., deep maneuver) using a threat overlay design. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	1.537	1.200
Title: Subsurface Forensics ***Description:*** Develops effective and covert methods to collect data and transmit telemetric signal through solid media to advance chemical and biological sensing to prepare Soldiers for the risks of deliberate or accidental release of toxic industrial chemicals and materials. ***FY 2021 Plans:*** Will investigate and assess chemical and biological sensing and sampling technologies to develop methods that identify risks of deliberate or accidental release of toxic industrial chemicals and materials in subterranean waste disposal networks. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funds realigned from other efforts in the Project.	-	-	1.131
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:***	-	0.079	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AR5 / *Understanding the Environment as a Threat Technolo*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	-	3.943	2.331

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AR7 / *Sensing in Contested Environments Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AR7: *Sensing in Contested Environments Technology*	-	0.000	0.000	1.888	-	1.888	1.207	0.985	0.996	0.000	0.000	5.076

Note

In Fiscal Year 2021 (FY21), this Project is a Restructure.

This Project had a Skip Year for funding for FY20 but was funded in FY19 in Program Element 0603728A Environmental Quality Technology Demo:
* 03E Environmental Restoration Technology

A. Mission Description and Budget Item Justification

This Project characterizes through direct or inferential methods the identification of non-weaponized biological hazards posed to Soldiers in operational environments by advancing sensor technologies. Sensor technologies and software modules will detect and characterize hazards including water quality, heavy metals in soils, breath-ability, and non-weaponized radiological hazards within confined environments. This effort supports the Common Operating Environment LOE. Research is transitioned to PE 0603463A (Network C3I Advanced Technology) / Project AR8 Sensing in Contested Environments Adv Tech.

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Non-Traditional Threat Detection in Contested Environment	-	-	1.888
Description: This effort identifies, examines and prioritizes commercial of the shelf capabilities from multiple sources that can accurately detect biological hazards relevant to operations in subterranean environments from point of ingress/egress to evaluate exposure potential and affects.			
FY 2021 Plans: Will assess candidate sensor technologies for maturity and effectiveness and design demonstration scenarios to detect and characterize hazards including water quality, heavy metals in soils, breath-ability, and non-weaponized radiological hazards to provide immediate warning of natural, man-made, and biological hazards that impact operations.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AR7 / *Sensing in Contested Environments Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
This Project had a Skip Year for funding for FY20 but was funded in FY19 in Program 0603728A Environmental Quality Technology Demo, Project 03E Environmental Restoration Technology			
Accomplishments/Planned Programs Subtotals	-	-	1.888

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AR9 / *Persistent Geophysical Sensing-Infrasound Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AR9: *Persistent Geophysical Sensing-Infrasound Tech*	-	0.000	3.963	3.150	-	3.150	3.456	2.698	2.498	2.274	0.000	18.039

Note

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

A. Mission Description and Budget Item Justification

This Project designs and develops algorithms, software, and hardware components to enable near-real-time battlespace awareness to persistently monitor (through non-line-of-sight sensing including infrasound) critical infrastructure conditions and threat activities in dynamic battlefields. These technologies provide near real time data collection, processing, and alerts of infrastructure go/no-go condition required for maneuver planning. This project also designs and develops methodologies to assign maneuver relevant engineering attributes to geospatial feature data such as bridge load classification, road condition, and bathymetry.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) /Project AS9 (Persistent Geophysical Sensing-Infrasound Tech Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Remote Assessment of Infrastructure for Ensured Maneuver (RAFTER)	-	3.891	-
Description: This effort develops parameters for a suite of geophysical and geosensing technologies to persistently assess infrastructure capability and condition for large areas including urban terrain; develops complex terrain, topography, and meteorological models related to acoustic propagation detected by the sensor suite, as well as signal processing algorithms for detection and classification of transportation infrastructure.			
FY 2020 Plans: Develop and refine algorithms associated with infrasound data processing for infrastructure monitoring as well as the urban, terrain, topographical, and meteorological models that feed into the analysis.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AR9 / *Persistent Geophysical Sensing-Infrasound Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
This research effort completes in FY2020.			
Title: Battlefield Intelligence by Geophysical Sensing (BIGS) ***Description:*** This effort investigates and develops a suite of geophysical and geo-sensing technologies to persistently assess battlefield elements to include infrastructure and additional sources of interest such as explosive and fires events and various air platforms; refines terrain, topography, and meteorological models related to acoustic propagation detected by the employed sensor suite as well as detection and classification signal processing algorithms for a broader range of sources and/or threats. ***FY 2021 Plans:*** Will design and develop algorithms associated with non-traditional sensing methods (including infrasound) for detecting, classifying, and monitoring additional sources of interest (explosive events, air platforms, etc.) as well as refinement of the terrain, topographical, and meteorological models that feed into the analysis. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Increase to initiate funding for the BIGS effort.	-	-	3.150
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.072	-
Accomplishments/Planned Programs Subtotals	-	3.963	3.150

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AT2 / *Subterranean Detection and Monitoring Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AT2: *Subterranean Detection and Monitoring Technology*	-	0.000	1.600	2.897	-	2.897	0.000	1.956	1.636	1.485	0.000	9.574

Note

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

A. Mission Description and Budget Item Justification

This Project designs and develops an integrated suite of tunnel detection, subterranean monitoring solutions, and vulnerability assessment technologies to detect, identify, and monitor subterranean threat activities in urban environments through advanced sensing and rapid analysis capabilities. This Project also develops and investigates enhanced technologies to detect tunnels and tunneling activity in complex and varied environments.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology / Project AT3 (Subterranean Detection and Monitoring Adv Tech).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Subterranean Threat Assessment by Real-time Sensing	-	1.527	2.897
Description: This effort designs and develops an integrated suite of tunnel detection and persistent surveillance technologies to detect, track, and identify subsurface activities; expedient underground municipal infrastructure detection system; urban source characterization and modeling algorithms; expedient void detection systems in urban areas, and vulnerability assessment tools for the urban subterranean domain.			
FY 2020 Plans: Design and develop a rapidly deployable passive seismic sensor system to detect subterranean activities of interest; mature electromagnetic induction transmitter component designs; and continue to investigate and conduct experiments on sensor coupling.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AT2 / *Subterranean Detection and Monitoring Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will design and develop ground-penetrating radar and seismic hardware for detection of underground municipal infrastructure; and develop sensing classifiers based on simulated urban source signatures. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Increased funding for further development and experimentation of ground-penetrating radar.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.073	-
Accomplishments/Planned Programs Subtotals	-	1.600	2.897

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AT7 / *Network-Enabled GeoSpatial-GEOINT Services Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AT7: *Network-Enabled GeoSpatial-GEOINT Services Tech*	-	0.000	2.992	4.001	-	4.001	4.692	1.033	0.000	0.000	0.000	12.718

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602784A Military Engineering Technology:
* Project 855 Topographical, Image Intel & Space
* Project T42 Terrestrial Science Applied Research

A. Mission Description and Budget Item Justification

This Project investigates and develops a revolutionary, integrated capability to rapidly share mission critical 3-dimensional (3D) information that supports planning and execution at the Soldier level. This will be achieved through the maturation of next-generation geospatial analytical models for 3D complex urban environment data, delivering enriched understanding of dynamic Operational Environments and distributed to a tactical Common Operating Environment. This Project will result in improved situational awareness and autonomy at low echelons, contributing to increased maneuver and mobility during manned and unmanned teaming operations.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) / Project AT8 (Network-Enabled GeoSpatial and GEOINT Services AdvTech).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Geo-registration, Analytical Tool Development and Visualization	-	2.856	3.007
Description: This effort investigates the design and formulation of new urban terrain data models, frameworks and processes to automate the geo-registration of 3D and 2-dimensional (2D) source data (e.g. light detection and ranging (LiDAR), imagery, Open Street Maps, and full motion video derived data) to new model constructs for rapid alerting to changes in the Operational Environment of interest.			
FY 2020 Plans: Investigate and compare software for accurately aligning 3D and 2D sources together, then adapt and/or develop new software to fully automate the alignment of these geospatial sources to maximize their utility for automated extractions and change detection			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AT7 / *Network-Enabled GeoSpatial-GEOINT Services Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
alerting within the Operational Environment; and initiate the design of an advanced 3D data processing framework meeting criteria for transformation of point cloud data to compact feature data models, 3D-data indexing and transmission algorithms. ***FY 2021 Plans:*** Will complete research and design of an advanced 3D data processing framework and algorithms for co-registration of disparate sources of time sensitive, tactical unit generated 3D geospatial data for incorporating into the unit?s tactical foundation terrain dataset. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Geospatial Data for Tactical Visualization ***Description:*** This effort develops new open source software, data models and processes to generate a vision-based geospatial foundation layer to enable end-users systems to visualize real-time mission critical geospatial content at the required level-of-detail (LOD) and enable position-navigation self-localization capability applicable to end-user devices at required accuracies optimized for the device, application, and mission. ***FY 2021 Plans:*** Will investigate new geospatial data models for 3D urban terrain supporting the generation of a vision-based foundation layer enabling end-user's systems to visualize real-time mission critical geospatial content at the required level-of-detail (LOD). ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY2021, includes realignment from PE 0603463A Network C3I Advanced Technology / Project AU6 Automated Analytics for Operational Environments AT.	-	-	0.994
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.136	-
Accomplishments/Planned Programs Subtotals	-	2.992	4.001

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AT7 / *Network-Enabled GeoSpatial-GEOINT Services Tech*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AT9 / *Tactical GeoSpatial Information Capabilities Techn*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AT9: *Tactical GeoSpatial Information Capabilities Techn*	-	0.000	2.771	4.240	-	4.240	1.798	0.000	0.000	0.000	0.000	8.809

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602784A Military Engineering Technology:
* Project 855 Topographical, Image Intel & Space

A. Mission Description and Budget Item Justification

This Project investigates and develops next generation geospatial analytical tools for 3-dimensional complex environments for low echelon and tactical edge exploitation. Research focuses on improving geospatial and Geospatial Intelligence (GEOINT) aspects of situational awareness at the tactical edge in the complex environment by exploiting new data sources, automating analytical tasks, and testing new collection technologies, including interiors of infrastructure. Research develops capabilities to enhance/update provisioned (baseline) standard, sharable, geospatial foundation (SSGF) data through automated analytics on multi-sourced spatial data resulting in streamlined, enhanced high fidelity terrain analysis products. Reducing data gaps and processing timelines will greatly increase Soldier situational awareness and support faster decision making in complex terrain.

Work in this Project complements PE 0603463A Network C3I Advanced Technology / Project AU1 (Tactical GeoSpatial Information Capabilities ATech).

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

Work in this Project is performed by the United States Army Engineer Research and Development Center (ERDC) and coordinated with the United State Army Futures Command

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: 3D Terrain Analysis	-	1.267	2.755
Description: This effort investigates and develops software models and workflows provisioned on the geospatial and GEOINT workstations for improved capabilities to generate, process and exploit terrain products enabling situational awareness and rapid decision making at the tactical edge.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AT9 / *Tactical GeoSpatial Information Capabilities Techn*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Investigate and build Distributed Common Ground System - Army (DCGS-A) compatible workflows that provision remotely sensed tactical data exploitation and conflation for geospatial and GEOINT workstations, enabling enhanced situational awareness and rapid decision making. ***FY 2021 Plans:*** Will research enhanced terrain processing algorithms to rapidly process higher resolution data (spatial and temporal), generating time sensitive geospatial products supporting tactical maneuver and protection in complex terrain. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increase to support enhanced terrain processing algorithms.			
Title: Airborne Light Detection and Ranging (LiDAR) ***Description:*** This effort investigates and develops enhanced Geiger-mode LiDAR hardware/software, for advanced testing of protocols, equipment, and products for improved high-altitude/wide area terrain data collection, to support tactical operations. ***FY 2020 Plans:*** Investigate new Geiger-mode LiDAR sensor payload components, for increasing performance and speed of collection and processing, for more realistic portrayal of multi-domain environments. ***FY 2021 Plans:*** Will research airborne LIDAR signal processing algorithms and calibration model frameworks, tailored for higher resolution 3D data collections over large areas, providing for extended collection stand-off and enhanced surface feature classification accuracies. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	1.379	1.485
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.125	-
Accomplishments/Planned Programs Subtotals	-	2.771	4.240

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AT9 / *Tactical GeoSpatial Information Capabilities Techn*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AU3 / *Geospatially Enabled Operational Design Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AU3: *Geospatially Enabled Operational Design Technology*	-	0.000	3.173	1.467	-	1.467	1.002	0.000	0.000	0.000	0.000	5.642

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
Program Element (PE) 0602784A Military Engineering Technology:
* Project 855 Topographical, Image Intel & Space

A. Mission Description and Budget Item Justification

This Project investigates, advances and develops a geospatially enabled collaborative planning environment, accessible across echelons, with capabilities that support Army Design Methodology (ADM) by providing the ability to perform conceptual planning and problem framing, supporting a greater understanding and visualization of the dynamic operational environment, a shared understanding of the operations purpose across echelons, and enhanced products to drive detailed planning (Military Decision Making Process - (MDMP) and the operational assessment process, enhancing the collaborative interaction between commanders, staffs, and unified action partners.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) /Project AU4 (Geospatially Enabled Operational Design Advanced Technology).

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

Work in this Project is performed by the United States Army Engineer Research and Development Center (ERDC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Virtual Collaborative Operational Design (GEOD) Research	-	1.770	1.467
Description: This effort investigates automation technologies to digitally visualize, create and assess critical elements of the Operational Environment required to inform the Operational Design functions, including collaborative conceptual framing of the problem by examining the differences between the current state of an operational environment and the desired end state.			
FY 2020 Plans: Research methodologies and tools to support ADM using digital collaboration tools to frame the problem and visualize the desired end state in a geospatial context.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AU3 / *Geospatially Enabled Operational Design Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will examine model approaches for visualizing differences between the natural tendency of an operational environment (OE) and desired future states of relevant actors with the desired end state (military objective) to include tensions (frictions, conflicts, and competitions) between relevant actors including geographic, demographic, economic, religious, and resource consumption trends. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Tactical Data Analysis and Visualization ***Description:*** This effort develops a suite of data aggregation analysis and visualization capabilities allowing commanders and staffs the capability to bridge conceptual planning to deliberate planning of the Military Decision Making Process (MDMP) at echelons down to battalion. ***FY 2020 Plans:*** Develop capabilities to geospatially enable strategic guidance inputs to operational design, in a digital, integrated, collaborative planning environment. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Realigned to accelerate GEOD in support of Modernization Priorities.	-	1.396	-
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.007	-
Accomplishments/Planned Programs Subtotals	-	3.173	1.467

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AU5 / *Automated Analytics for Operational Environment*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AU5: *Automated Analytics for Operational Environment*	-	0.000	3.950	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.950

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
Program Element (PE) 0602784A Military Engineering Technology:
* Project 855 Topographical, Image Intel & Space

In FY21 this Project is Eliminated.

A. Mission Description and Budget Item Justification

This Project investigates, advances and develops algorithms for automated extraction of relationships between the population and the operational environment. Linking the data points across multiple domains to include patterns of life will result a greater understanding of the operational environment enabling the Mission Analysis phase of detailed planning (Military Decision Making Process). Work supports the Common Operating Environment research effort. Research is transitioned to PE 0603463A (Network C3I Advanced Technology) Project AU6 (Automated Analytics for Operational Environment) Advanced Technology.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Simultaneous Multi-Domain Data Representation	-	1.833	-
Description: This effort investigates and develops advanced capabilities to provide commanders and staff with the ability to understand and operate in multiple domains simultaneously, by proposing and validating new data models and encoding for threat actors and actions, and operational environment characterization optimized across multiple domains in the battlespace, and represented geospatially.			
FY 2020 Plans: Investigate spatio-temporally coherent multi-domain data representations that capture explicit and implicit relationships between threat actors distilled from raw text content data; and develop a flexible suite of geospatial methods and algorithms for processing and correlating heterogeneous data streams generated from multiple domains using feature signatures.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AU5 / *Automated Analytics for Operational Environment*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
This research effort concludes in FY20.			
Title: Automated Analysis of Multi-Domain Data ***Description:*** This effort investigates and develops data models to support automated understanding and analysis and advanced relevancy ranking approaches to identify and prioritize knowledge gaps and contextualized results. ***FY 2020 Plans:*** Investigate algorithms for automated threat pattern and non-threat categorization, and changes to the operational environment that may be revealed across multiple diverse data sources. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This research effort concludes in FY20.	-	2.096	-
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.021	-
Accomplishments/Planned Programs Subtotals	-	3.950	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AV3 / *Foundational S&T for Network C3I Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AV3: *Foundational S&T for Network C3I Technology*	-	0.000	0.000	1.927	-	1.927	1.968	2.101	2.208	2.208	0.000	10.412

Note

In Fiscal Year 2021 (FY21), this Project is a Restructure.

This Project had a Skip Year for funding for FY20 but was funded in FY19 in Program Element (PE) 0602270A Electronic Warfare Technology.

A. Mission Description and Budget Item Justification

This Project develops underlying technologies applicable to artificial intelligent agents and holistic network integration as applied to, but not limited to autonomous manned-unmanned teaming for ground and air platforms. This Project also matures emerging research leading to potential technology development in areas of strategic importance to the Army in network technologies, by bringing competitively selected Universities with research teams into Technical Alliances.

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

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

This work is done in coordination with PE 0603463A (Network C3I Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Development of Foundational technologies for holistic network integration ***Description:*** This Project develops underlying technologies applicable to next generation networks and integration of the same. ***FY 2021 Plans:*** Will investigate and research foundational technologies focusing on autonomy, Artificial intelligence/Machine Learning as applicable to, but not limited to, holistic network integration. Will investigate autonomy-related machine learning technologies, advanced teaming, and navigation/routing necessary for the Ground and Air platforms in support of the Army Modernization Priorities ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increase due to realignment from PE 0602270A / Electronic Warfare Technology after a Skip Year in FY20.	-	-	1.927
Accomplishments/Planned Programs Subtotals	-	-	1.927

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AV3 / *Foundational S&T for Network C3I Technology*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AV5 / *Protective Technologies*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AV5: *Protective Technologies*	-	0.000	6.800	7.692	-	7.692	7.839	6.443	6.515	6.580	0.000	41.869

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
Program Element (PE) 0602705A Electronics and Electronic Devices:
* Project H94 Elect & Electronic Devices

A. Mission Description and Budget Item Justification

This Project develops tools, devices, and techniques to protect acquisition program systems and Critical Program Information (CPI) from adversarial threats.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Protective Technologies ***Description:*** This effort develops tools, devices, and techniques to protect acquisition program systems and Critical Program Information (CPI) from adversarial threats. ***FY 2020 Plans:*** Integrate threat-based sensors and enhance secure processor intellectual property (IP) for enhanced Rigor 1b second engineering model; develop full Rigor 1a engineering models; perform laboratory characterization of Rigor 1a module; and develop the designs for Rigor 1c and Rigor 1d modules. ***FY 2021 Plans:*** Will develop Rigor 1b second engineering model for laboratory characterization and application part qualification activities; develop initial designs for additional Rigor modules; evaluate commercial and other Government agency security solutions for AT enhancement; and develop next generation Systems Engineering Development tailored for DoD Rapid Acquisition systems. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Planned program increase.	-	6.491	7.692
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638	-	0.309	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AV5 / *Protective Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	-	6.800	7.692

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AV6 / *Airborne Engineering Support Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AV6: *Airborne Engineering Support Technology*	-	0.000	0.882	0.899	-	0.899	0.917	0.935	0.946	0.946	0.000	5.525

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
Program Element (PE) 0602782A Command, Control, Communications Technology:
* Project 779 Command, Control and Platform Electronics Tech

A. Mission Description and Budget Item Justification

This Project supports advanced Command, Control, Communications, Intelligence, Surveillance and Reconnaissance (C3ISR) research and development technologies for airborne, and air-to-ground based testing of emerging Radio Frequency (RF) technologies.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Airborne Engineering Support Technology ***Description:*** This effort supports the demonstration of new and emerging C3ISR technologies. This venue performs technology assessments by evaluating candidate technologies in support of the Army Modernization Priorities. Demonstration events are determined by the maturity of the tech base programs across the Army?s Science and Technology (S&T) C3ISR portfolio. ***FY 2020 Plans:*** Investigate and provide early performance feedback to S&T efforts that are developing technologies to provide robust and adaptive intelligence, electronic support, and electronic warfare capabilities. ***FY 2021 Plans:*** Will evaluate performance of S&T technologies developed to provide robust and adaptive intelligence, electronic support, and electronic warfare capabilities. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Planned program increase.	-	0.842	0.899
Title: FY 2020 SBIR/STTR Transfer	-	0.040	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AV6 / *Airborne Engineering Support Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	-	0.882	0.899

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AV7 / *Atmospheric Modeling and Meterological Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AV7: *Atmospheric Modeling and Meterological Technology*	-	0.000	5.812	5.945	-	5.945	6.064	6.186	6.255	6.318	0.000	36.580

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
Program Element (PE) 0602784 Military Engineering Technology:
* Project H71 Meteorological Research for Battle Command

A. Mission Description and Budget Item Justification

This Project develops tactical atmospheric sensing, modeling, and decision support technologies. New atmospheric sensing technologies are developed that enable near-real-time, high-resolution measurements of atmospheric parameters via light-weight systems that can be employed in tactical domains. Efforts include high-resolution local assessments and forecasts of meteorological conditions that can accommodate the effects of dense urban and complex, mountainous terrain. Both physics-based and rule-based decision support systems are developed for assessing the impacts of weather/atmosphere across a spectrum of friendly and threat weapons systems, sensors, platforms, and operations. It provides detailed model applications for various effects of the atmosphere on electro-optical and acoustic target detection, location, and identification. Information can be applied to mission planning and execution; battlefield visualization; reconnaissance, surveillance, and target acquisition, route planning to maximize stealth and efficiency, web-enabled tactical decision aids, long-range precision fires; and modeling of environmental impacts for combat simulations and war games

This work provides technologies for evaluation by and/or transitions to the Department of Defense weather and operations community including: Program Executive Office (PEO) Ammunition-PM Combat Ammunition Systems (CAS) and Marine Corps Systems Command (MCSC) for meteorological message input to field artillery targeting systems; Project Manager, Distributed Common Ground System-Army (DCGS-A); the US Air Force 557th Weather Wing and the Air Force Life Cycle Management Center (AFLCMC) to improve their operational weather support to the Army.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Atmospheric Characterization, Modeling, and Impacts	-	5.548	5.945
Description: This effort develops environmental situational understanding enabled though coupled sensing, modeling, and decision support technologies for data-sparse, computationally-limited, and network-constrained domains.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AV7 / *Atmospheric Modeling and Meterological Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Apply stochastic collocation methods to Weather Running Estimate ? Nowcast (WRE-N) and Atmospheric Boundary Layer Environment (ABLE) model simulations over the Meteorological Sensor Array (MSA) region in and adjacent to White Sands Missile Range, NM, to compute quantitative forecast uncertainty metrics, improve risk understanding (or management), and increase decisiveness; examine model uncertainty and optimize WRE-N physics configurations over diverse geographic settings; update model algorithms to enable efficient operations on mobile computing architectures supporting decide-faster scenarios; demonstrate upgraded model operation in complex terrain domains for improved targeting for long range fires; enhance atmospheric impacts decision aids for ground and air maneuver including strategic-level solutions (e.g. climatology data inputs), route optimization (i.e., including environmental variables and urban area buildings), assessing autonomous systems at the Dense Urban Environment (DUE) MSA testbed, implementing fuel consumption computations along a mission route, characterizing atmospheric hazards for airfields; and develop techniques to implement environmental inputs into a next-generation acoustic propagation decision support tool to support threat detection. ***FY 2021 Plans:*** Will implement and assess machine learning techniques applied to path optimization (air and surface) through atmospheric hazards including strategic-level solutions (e.g. climatological time-scales) and obstacles; implement and assess machine learning techniques applied to environmental effects on directed energy propagation, including strategic-level solutions (e.g. climatological time-scales); conduct validation study of Atmospheric Boundary Layer Environment Lattice-Boltzmann Method (ABLE-LBM) forecast model over forested, complex terrain using observational data from the Perdig?o, Portugal field experiment; establish robust radar and satellite data assimilation capabilities for use with numerical weather prediction models such as Weather Running Estimate - Nowcast (WRE-N); utilizing database of sub-km WRE-N model simulations over the Meteorological Sensor Array (MSA) and Design of Experiments expertise, quantify the primary sources of model uncertainty and loss of predictability in sub-km numerical weather prediction; optimize Doppler Light Detection and Ranging (LiDAR) wind retrieval algorithms for low-power and low-computer architectures/platforms; implement viable range-dependent environmental input techniques into a next-generation acoustic propagation decision support tool to augment threat detection; and employ surrogate models for physical self-awareness for autonomous flight of unmanned aerial vehicles (UAVs) to incorporate differing, static weather conditions; adapt surrogate models for use on resource-constrained usage on computer hardware on UAVs. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Planned program increase.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:***	-	0.264	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AV7 / *Atmospheric Modeling and Meterological Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Funding transferred in accordance with Title 15 USC ?638			
FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	-	5.812	5.945

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AV9 / *Advanced PNT for GPS Independent Environments Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AV9: *Advanced PNT for GPS Independent Environments Tech*	-	0.000	6.974	6.656	-	6.656	10.357	8.735	8.833	8.834	0.000	50.389

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
Program Element (PE) 0602705 Electronics and Electronic Devices:
* Project H94 Elect & Electronic Dev

A. Mission Description and Budget Item Justification

This Project develops technologies that will enable precise and assured Positioning, Navigation and Timing (PNT) in Global Positioning System (GPS)-denied environments. This Project develops technologies addressing the PNT's toughest Scenario - Scenario 4 (no available GPS signal during the mission duration) with a goal of enabling Soldier missions of up to seven days in a GPS denied environment. This is achieved with research addressing advanced quantum timing circuits, advanced inertial measurement unit (IMU) components, multi-sensor modalities, perception techniques, geo-location data, vision aided navigation sensors, and available RF signals.

This research also addresses the PNT Scenarios 1 (GPS operations that start good and have degraded GPS signals throughout the mission duration) through Scenario 3 (GPS operations have 'bad' or limited availability of GPS signals throughout the entire mission). This is achieved with research addressing the ability to transmit jam-resistant, precision timing synchronized signals using optical fibers, free-space using lasers, and in the radio frequency (RF) domain using innovative RF antenna concepts to extend the reach of Soldier compatible capabilities in heavily contested GPS 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 is performed by the United States Army Futures Command.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Precision Measurement Technology for Contested Environments	-	2.898	3.054
Description: This effort will develop technologies that will enable precise and assured PNT in GPS-denied environments for up to 1 hour. This research will improve the accuracy while also focusing on size, weight, power, cost (SWAP-C) of current IMUs through the design, fabrication, and testing of novel micro-electromechanical system (MEMS) sensor designs and materials and the integration of multiple sensor modalities with the IMUs using sensor fusion and perception techniques to reduce drift and increase positional accuracy. Research will also include the ability to transmit jam-resistant precision position, navigation, and timing signals via electro-optical and/or RF transmission methods.			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AV9 / *Advanced PNT for GPS Independent Environments Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2020 Plans: Refine modeling designs for novel MEMS IMU using advanced MEMS materials, cavity designs, and micro-structures; develop and evaluate micro-structures demonstrating improved MEMS IMU accuracy; refine algorithms enabling vision-based geolocalization, and demonstrate impact of drift correction techniques on the performance of MEMS IMU operations in representative operational environments (temperature and vibration); and fabricate and evaluate core components, techniques, and methods for chip-scale fiber combs. ***FY 2021 Plans:*** Will implement refined designs based on prior modeling for novel MEMS IMUs using advanced MEMS materials and micro-structures; develop and assess advanced micro-structures demonstrating improved MEMS IMU accuracy; validate algorithms enabling vision-based geo-localization, and improve drift correction techniques on the performance of MEMS IMU operations in representative operational environments (temperature and vibration); develop chip-scale, low-noise stabilized frequency source based on integrated electro-optic frequency combs for SWaP-C constrained timing methods; and develop system models for multi-node, anti-jam performance in the 600 MHz to 6 GHz and 24-86 GHz bands. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Quantum Effects for Assured PNT in Zero-GPS Environments ***Description:*** This effort will conduct research on SWAP-C quantum based timing sub-systems, incorporating advanced sensors, RF signals (beyond GPS), navigation databases, and advanced algorithms. This effort incorporates advanced quantum timing circuits, advanced IMU components, multi-sensor modalities, perception techniques, geolocation data, vision aided navigation sensors, and available RF signals in order to increase precise and assured PNT operations in a GPS ? denied environments for up to 7 days. ***FY 2020 Plans:*** Refine quantum based timing designs (e.g., materials, cavity, integrated optical coupling) with modeled performance and representative operational environments (temperature and vibration); develop and evaluate a laboratory quantum based timing design compatible blue laser (blue laser required for full functionality of the quantum timing operations); develop designs and methods for chip-scale, integrated opto-electronic controls for SWaP-C constrained quantum based timing methods; develop an embedded hybrid multi-sensor fusion engine with continuous Inertial Navigation System (INS) calibration; and develop an integrated, multi-modal, inertial navigation capability to evaluate the multi-sensor fusion engine and perform continuous INS calibration. ***FY 2021 Plans:***	-	3.759	3.602

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AV9 / *Advanced PNT for GPS Independent Environments Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will refine quantum based timing designs with modeled performance and representative operational environments, targeting improved performance for a chip-scale atomic clock; develop and assess materials growth to enable blue laser required for quantum based timing design; integrate a minimum of three heterogeneous sensor modalities into an embedded hybrid multi-sensor fusion engine with continuous Inertial Navigation System (INS) calibration capable of interfacing with the Department of Defense PNT Open Architecture standards; and integrate and assess a multi-modal, inertial navigation capability to validate the multi-sensor fusion engine and perform continuous INS calibration in a relevant environments. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Planned program decrease.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.317	-
Accomplishments/Planned Programs Subtotals	-	6.974	6.656

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AW1 / *Autonomous Navigation Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AW1: *Autonomous Navigation Technology*	-	0.000	0.400	1.798	-	1.798	2.198	2.098	0.000	0.000	0.000	6.494

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
Program Element (PE) 0602782A Command, Control, Communications Technology:
* Project 779 Command, Control and Platform Electronics Tech

A. Mission Description and Budget Item Justification

This Project investigates use of sensors on the platform and available navigation signals to the localization and decision making of Robotic/Autonomous Systems. Additionally, it examines the use of machine learning algorithms for cooperative navigation to aid in a Positioning, Navigation and Timing (PNT) solution. This will enable the user to achieve operational overmatch in a Global Positioning System (GPS) impeded environment as well as enhanced navigation (reducing dependence on GPS) through challenging terrains.

Work in this Project complements PE060343A (Network C3I Advanced Technology) / Project AW2 (Autonomous Navigation Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Autonomous Navigation Technology	-	0.382	-
Description: This effort leverages Assured PNT efforts that improve localization and decision making of Robotic/Autonomous Systems by optimizing use of sensors on the platform and taking advantage of all available navigation signals. It examines the use of machine learning algorithms for cooperative navigation to aid in a PNT solution.			
FY 2020 Plans: Develop and evaluate a ground vehicle navigation algorithm based on unmanned aerial vehicle (UAV) imagery data for the localization and heading estimation of unmanned ground vehicles (UGVs); develop and investigate alternative methods of UAV-based ground vehicle identification utilizing fiducial markers and deep learning algorithms; and investigate and validate methodologies to combine UGV localization and identification algorithms through simulation.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AW1 / *Autonomous Navigation Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
This effort ended after FY20.			
Title: Intelligent Electronic Protect (IEP) ***Description:*** This effort provides assured access to PNT in degraded electromagnetic (jamming), space, or cyber environments;notifies Soldiers, Systems, and Platforms when PNT cannot be trusted for mission duration; provides Soldiers, Systems, and Platforms a reduction in the likelihood of being spoofed for mission duration; provides unhindered access to military Global Positioning System (GPS) level of accuracy when access to military GPS is unavailable; and facilitates graceful degradation of PNT systems when military GPS is denied or degraded. ***FY 2021 Plans:*** Will investigate assured access to PNT in degraded electromagnetic (jamming), space, or cyber environments; validate unhindered access to military Global Positioning System (GPS) level of accuracy when access to military GPS is unavailable. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Realigned from PE 0603463A Network C3I Advanced Technology, Project AV8 Navigation Warfare (NAVWAR) Advanced Technology in support of Modernization Priorities.	-	-	1.798
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.018	-
Accomplishments/Planned Programs Subtotals	-	0.400	1.798

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AW3 / *DoD PNT M&S Collaborative Initiative (CI) Technolo*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AW3: *DoD PNT M&S Collaborative Initiative (CI) Technolo*	-	0.000	2.000	1.998	-	1.998	0.000	0.000	0.000	0.000	0.000	3.998

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
Program Element (PE) 0602782A Command, Control, Communications Technology:
* Project 779 Command, Control and Platform Electronics Tech

A. Mission Description and Budget Item Justification

This Project designs and develops Positioning, Navigation and Timing (PNT) modeling and simulation (M&S) frameworks and tools to provide Department of Defense (DoD) with the capability to conduct analysis and create quantifiable data on the impact of PNT technologies on warfighters and missions operating in a denied or degraded Global Positioning System (GPS) environment. Additionally, it provides senior leadership with the information required to understand the value of PNT investment versus the improvement in mission performance and operational effectiveness. This Project also assess the effectiveness and maturity of complementary PNT systems/sensors.

Work in this Project complements PE 0603463 (Network C3I Advanced Technology) / Project AW4 (DoD PNT M&S Collaborative Initiative Adv Tech).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: DoD PNT M&S Collaborative Initiative (CI)	-	1.909	1.998
Description: This effort designs and develops PNT M&S frameworks and tools to provide DoD with the capability to conduct analysis and create quantifiable data on the impact of PNT technologies on warfighters and missions operating in a denied or degraded GPS environment. Additionally, it provides Senior leadership with the information required to understand the value of PNT investment versus the improvement in mission performance and operational effectiveness. This effort also assess the effectiveness and maturity of complementary PNT systems/sensors. Work accomplished under PE 0603463A/Project AW4 (DoD PNT M&S Collaborative Initiative Advanced Technology) complements this effort.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AW3 / *DoD PNT M&S Collaborative Initiative (CI) Technolo*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Design and develop an architecture, framework, catalogue, repository and models for complementary PNT technologies. ***FY 2021 Plans:*** Will complete the design and development of an architecture, framework, catalogue, repository and models for complementary PNT technologies; and produce final technical reports documenting the federated Tri-service M&S capability. Completed M&S capability will be integrated into Army, Navy, and Air Force M&S environments. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.091	-
Accomplishments/Planned Programs Subtotals	-	2.000	1.998

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AW5 / *Modular GPS Independent Sensors Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AW5: *Modular GPS Independent Sensors Technology*	-	0.000	4.140	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.140

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
Program Element (PE) 0602782A Command, Control, Communications Technology:
* Project 779 Command, Control and Platform Electronics Tech

In FY21 this Project is Eliminated.

A. Mission Description and Budget Item Justification

This Project performs research and development of modular Global Positioning System (GPS)-independent sensors and an open architecture sensor fusion core enabling simple, plug-and-play sensor modules that can be tailored for any platform based on mission needs and requirements.

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) / Project AW6 (Modular GPS Independent Sensors Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Modular GPS Independent Sensors	-	3.952	-
Description: This effort performs research and development of modular GPS-independent sensors and an open architecture sensor fusion core enabling simple, plug-and-play sensor modules that can be tailored for any platform based on mission needs and requirements.			
FY 2020 Plans: Continue to develop Quad Mass Gyro Inertial Measurement Units and investigate Infrared Vision Sensors for use in positioning, navigation, and timing (PNT) solutions; develop a PNT sensor fusion core and sensor fusion modules; Will develop algorithms for PNT integrity; design a PNT Software Defined Receiver; and investigate other existing sensors to be used in a PNT solution.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** AW5 / *Modular GPS Independent Sensors Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Research effort concludes in FY20.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.188	-
Accomplishments/Planned Programs Subtotals	-	4.140	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** BP2 / *Sensor and Electronic Network Initiatives (CA)*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BP2: *Sensor and Electronic Network Initiatives (CA)*	-	0.000	23.500	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	23.500

Note

Congressional Interest Item funding provided for Sensor and Electronic Network Initiatives.

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Sensor and Electronic Network Initiatives.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Small Satellite Technology ***FY 2020 Plans:*** Small Satellite Technology	-	3.000
Congressional Add: Radioisotope Power Systems ***FY 2020 Plans:*** Radioisotope Power Systems	-	2.500
Congressional Add: Anti-Tamper Technology Development ***FY 2020 Plans:*** Anti-Tamper Technology Development	-	10.000
Congressional Add: Next Generation Synthetic Aperture ***FY 2020 Plans:*** Next Generation Synthetic Aperture	-	5.500
Congressional Add: Sensing Technologies for Rapid Hazard Detection ***FY 2020 Plans:*** Sensing Technologies for Rapid Hazard Detection	-	2.500
Congressional Adds Subtotals	-	23.500

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** BP2 / *Sensor and Electronic Network Initiatives (CA)*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / *Network C3I Technology*	Project (Number/Name) BZ6 / *Narrowband SATCOM Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BZ6: *Narrowband SATCOM Technology*	-	0.000	0.000	0.999	-	0.999	0.000	0.000	0.000	0.000	0.000	0.999

Note

Fiscal Year 2021 (FY21) funding is realigned from:
Program Element (PE) 0602143A Soldier Lethality:
* Project AN1 Narrowband SATCOM Technology

A. Mission Description and Budget Item Justification

This Project designs and develops technologies to enable Army Narrowband Satellite Communications (SATCOM) networks to control traditional military tactical SATCOM along with non-traditional networks, such as commercial networks, to enable adaptability of the narrowband SATCOM network in a contested environment.

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

Work in this Project complements PE 0603463A (Network C3I Advanced Technology) / Project AN2 (Narrowband SATCOM Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Narrowband Satellite Communication Technology	-	-	0.999
Description: This project designs and develops technologies to enable Army Narrowband Satellite Communications (SATCOM) networks to control traditional military tactical SATCOM along with non-traditional networks, such as commercial networks, to enable adaptability of the narrowband SATCOM network in a contested environment.			
FY 2021 Plans: Will develop emulator configuration and develop an agile, network-defined architecture that enables gateway communications across Narrowband SATCOM networks; and develop system engineering documentation and user documentation for the architecture.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** BZ6 / *Narrowband SATCOM Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Realigned from PE 0602143A Soldier Lethality Technology, Project AN1 Narrowband SATCOM Technology in support of Modernization Priorities.			
Accomplishments/Planned Programs Subtotals	-	-	0.999

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** BZ8 / *Aerial Teir Networking (High Altitude)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BZ8: *Aerial Teir Networking (High Altitude)*	-	0.000	0.000	0.400	-	0.400	0.400	1.399	4.854	3.654	0.000	10.707

Note

In Fiscal Year 2021 (FY21) this Project was realigned from:
Program Element (PE) 0602146A Network C3I Technology:
* Project AO2 Stand-In Advanced RF Effects (STARE)

A. Mission Description and Budget Item Justification

This Project designs and develops technologies for aerial networking to establish line of sight and beyond line of sight communications.

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

Project is performed by the United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Aerial Tier Networking (High Altitude) ***Description:*** Develop a Wideband Global Satellite Communications (WGS) surrogate payload for usage on a High Altitude Platform (HAP) with seamless transition to existing ground terminals by modifying existing solutions to support Network Modernization Capability Sets (CS) beginning with CS23 - Capacity & Resiliency. ***FY 2021 Plans:*** Will investigate the capability, performance parameters and operational requirements which can be achieved without changing existing SATCOM terminals and modems. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding realigned from PE 062146A Network C3I Technology, Project AO2 Stand-In Advanced RF Effects (STARE).	-	-	0.400
Accomplishments/Planned Programs Subtotals	-	-	0.400

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602146A / *Network C3I Technology*	**Project (Number/Name)** BZ8 / *Aerial Teir Networking (High Altitude)*

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army												Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**	**FY 2022**	**FY 2023**	**FY 2024**	**FY 2025**	**Cost To Complete**	**Total Cost**
Total Program Element	-	0.000	120.327	60.553	-	60.553	65.959	56.015	54.169	72.394	0.000	429.417
AE7: *Land-Based Anti-Ship Missile (LBASM) Technology*	-	0.000	11.420	22.677	-	22.677	14.227	0.000	0.000	0.000	0.000	48.324
AF1: *Long Range Maneuverable Fires (LRMF) Technology**	-	0.000	0.000	0.000	-	0.000	5.095	7.094	7.267	8.285	0.000	27.741
AF3: *Extended Range Propulsion Technology*	-	0.000	5.596	6.595	-	6.595	10.008	11.114	10.857	27.789	0.000	71.959
AF5: *Simulation and Aerostructures Technology*	-	0.000	1.376	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.376
AF6: *Structures Technology*	-	0.000	1.195	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.195
AF7: *Warhead Integration Technology*	-	0.000	1.681	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.681
AF8: *Affordable Extended Range Precision Technology*	-	0.000	0.288	8.491	-	8.491	8.792	9.391	9.623	8.850	0.000	45.435
AF9: *Precision and Accuracy Technology*	-	0.000	8.230	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	8.230
AG1: *Missile Electronics Technology*	-	0.000	3.021	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.021
AG2: *Information and Signal Processing Technology*	-	0.000	1.602	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.602
AG4: *Extended Range Artillery Munition Suite Technology*	-	0.000	6.806	8.667	-	8.667	11.889	12.126	13.572	14.490	0.000	67.550
AG6: *Energetic Materials and Advanced Processing Techno*	-	0.000	6.607	3.430	-	3.430	3.511	3.581	0.000	0.000	0.000	17.129
AG8: *Advanced Energetics Technology*	-	0.000	10.098	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	10.098
AG9: *Multiple Simul Engagement Technologies (MSET) Tech*	-	0.000	2.062	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	2.062

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army												Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*							
AH2: *Single Multi-mission Attack Missile (SMAM) Technol*	-	0.000	1.264	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.264
AH4: *Precision and Coop Weapons in a Denied Env Tech*	-	0.000	9.121	9.628	-	9.628	9.822	10.042	10.154	10.257	0.000	59.024
BN5: *Fuze and Power for Munitions*	-	0.000	0.960	1.065	-	1.065	2.615	2.667	2.696	2.723	0.000	12.726
BO9: *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE (CA)*	-	0.000	49.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	49.000

*This project's R-2a exhibit has been suppressed due to funding not beginning until after FY 2021

Note

In Fiscal Year (FY) 2020, this Program Element (PE) was realigned with continuity of effort from the following PEs:
* 0602303A Missile Technology
* 0602618A Ballistics Technology
* 0602624A Weapons and Munitions Advanced Technology

A. Mission Description and Budget Item Justification

Work in this PE investigates and develops Long Range Precision Fires (LRPF) technologies to destroy, neutralize, or suppress the enemy by cannon artillery and missile fire and enable integration of fire support assets into combined arms operations. Major Focus Areas for LRPF Science and Technology include: Missiles, Cannon Artillery, and Supporting LRPF Technologies covering Strategic, Operational and Tactical Fires Lines of Effort. LRPF Missiles Applied Research investigates and develops a broad range of Missile technologies to enhance Army integrated LRPF capabilities at extended range. Cannon Artillery Applied Research investigates and develops critical technologies to increase range, precision, and both point and area effects for cannon artillery. Supporting LRPF Technologies Applied Research investigates and develops a broad range of component technologies to address weapon cost drivers and enhance performance of future LRPF munitions and systems.

Work in this PE complements PE 0603464A (Long Range Precision Fires Advanced Technology).

The cited work is consistent with the Assistant 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 (AFC).

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	0.000	74.327	74.097	-	74.097
Current President's Budget	0.000	120.327	60.553	-	60.553
Total Adjustments	0.000	46.000	-13.544	-	-13.544
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-3.000			
• Congressional Rescissions	-	-			
• Congressional Adds	-	49.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	-13.544	-	-13.544

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2019	FY 2020
Project: BO9: *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE (CA)*		
Congressional Add: *Composite Cannon Tubes and Propulsion Technology*	-	10.000
Congressional Add: *Hybrid Projectile Technology*	-	6.000
Congressional Add: *Additive Manufacturing to Support Optimized Fires*	-	5.000
Congressional Add: *Program Increase*	-	20.000
Congressional Add: *Novel Printed Armament Components*	-	8.000
Congressional Add Subtotals for Project: BO9	-	49.000
Congressional Add Totals for all Projects	-	49.000

Change Summary Explanation

FY20 increase is the result of Congressional Adds.

FY21 decrease due to realignment in support of higher priority Army Science and Technology (S&T) efforts including realignment of foundational Advanced Energetics work to PE 0602141A (Lethality Technology)/Project AH9 (Advanced Warheads).

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AE7 / *Land-Based Anti-Ship Missile (LBASM) Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AE7: *Land-Based Anti-Ship Missile (LBASM) Technology*	-	0.000	11.420	22.677	-	22.677	14.227	0.000	0.000	0.000	0.000	48.324

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602303A Missile Technology:
*Project 214 Missile Technology

A. Mission Description and Budget Item Justification

This Project directly supports Long Range Precision Fires Modernization Priority capabilities by investigating and developing critical technologies to detect, engage, and defeat moving land or maritime surface targets under all conditions, and technologies for Precision Strike Missile (PrSM) payloads.

Work in this Project complements PE 0603464A (Long Range Precision Fires Advanced Technology) / AE8 (Land Based Anti-Ship Missile (LBASM) Advanced Tech.

The cited work is consistent with the Assistant 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 (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Land Based Anti-Ship Missile (LBASM) Technology	-	10.902	10.089
Description: Investigate and develop critical technologies that enable High Mobility Artillery Rocket System (HIMARS) and Multiple Launch Rocket System (MLRS) rocket/missile artillery systems to destroy enemy air defenses in the land and the maritime domains.			
FY 2020 Plans: Will continue development of multi-mode seeker technologies for precision engagement of cross-domain threats in GPS denied or degraded environments. These technologies include miniaturization of radio frequency and imaging infrared sensors; advanced image processing to enable target classification and aim point selection for both land and maritime targets.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AE7 / *Land-Based Anti-Ship Missile (LBASM) Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will evaluate the performance of the multi-mode seeker component technologies through conducting experiments with seeker hardware in the loop to mature tracking, identification and aim-point algorithms; will design payload concept evaluation to determine lethality against both land and maritime targets. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Decrease in funding associated with the development of the seeker technologies ramping down, and integration and testing ramping up in PE603464A (Long Range Precision Fires) / AE8 (Land-Based Anti-Ship Missile (LBASM) Advanced Tech) effort.			
Title: Precision Strike Missile Modular Payload Technology ***Description:*** Investigate and develop critical technologies for the delivery of dedicated Army intelligence, surveillance and reconnaissance (ISR) payloads and attack capabilities via long range missiles. Technology examples include: ISR sensor and associated signal processing technologies for target acquisition, identification, and engagement; datalink and communications technologies to transmit targetable data; compact propulsion technologies to enable loiter time on station; and payload dispensing technologies for deploying these payloads from high speed long range missiles. ***FY 2021 Plans:*** Will conduct trade studies to develop the system concept and derive system level technology requirements for the payload subsystems including ISR sensor, datalink, propulsion, and deployment mechanization; will identify critical technologies associated with each subsystem, and will initiate the development of preliminary designs for each subsystem to support required payload capabilities. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In Fiscal Year 2021, effort realigned from existing missile technology development in: PE 0602147A Long Range Precision Fires Technology *Project AF5 Simulation and Aerostructures Technology *Project AF9 Precision and Accuracy Technology *Project AG2 Information and Signal Processing Technology *Project AF6 Structures Technology *Project AF7 Warhead Integration Technology *Project AG1 Missile Electronics Technology *Project AF8 Affordable Extended Range Precision Technology PE 0603464A Long Range Precision Fires Advanced Technology	-	-	12.588

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AE7 / *Land-Based Anti-Ship Missile (LBASM) Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
*Project AF4 Missile Simulation			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.518	-
Accomplishments/Planned Programs Subtotals	-	11.420	22.677

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AF3 / *Extended Range Propulsion Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AF3: *Extended Range Propulsion Technology*	-	0.000	5.596	6.595	-	6.595	10.008	11.114	10.857	27.789	0.000	71.959

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602303A Missile Technology:
*Project 214 Missile Technology

A. Mission Description and Budget Item Justification

This Project directly supports Long Range Precision Fires Modernization Priority capabilities by designing, fabricating, and investigating missile enabling propulsion technologies to enable range extension and/or block speed improvement for long range applications; and enables improvement in High Performance Propellants (HPP) via gains in energy density and burn rate control.

Work in this Project complements PE 0603464A (Long Range Precision Fires Advanced Technology) / Project AF2 (Long Range Maneuverable Fires (LRMF) Advanced Tech).

The cited work is consistent with the Assistant 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 (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Extended Range Propulsion Technology	-	5.342	6.595
Description: Designs, fabricates, and investigates missile enabling propulsion technologies to enable significant range extension and/or block speed improvement for long range applications and enables improvement in HPP via gains in energy density and burn rate control.			
FY 2020 Plans: Will continue the design and develop of variable thrust/impulse control sub- system technologies that can efficiently operate over extended duty cycles, altitudes, and tactical temperatures providing enhanced controllability for high speed, high altitude missile applications; Will investigate and develop low cost integral air-breathing propulsion technology that enables significant range extension and/or block speed improvement for long range multi-domain fires applications.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AF3 / *Extended Range Propulsion Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will design air breathing propulsion component technology for cannon and rocket/missile artillery systems range extension; will investigate advanced technologies to increase the amount of energy delivered from the same form factor; investigate propellant processing techniques that can reduce manufacturing time and cost; investigate advanced propellant formulations and plume signature management technologies that can increase the survivability of long range fires platforms while maintaining or improving performance. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY21 funding increase due to fabrication of technology components and evaluation of advanced propellant formulations.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.254	-
Accomplishments/Planned Programs Subtotals	-	5.596	6.595

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AF5 / *Simulation and Aerostructures Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AF5: *Simulation and Aerostructures Technology*	-	0.000	1.376	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.376

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602303A Missile Technology:
* Project 214 Missile Technology

In FY21 this Project is realigned to:
PE 0602147A Long Rang Precision Fires Technology:
* Project AE7 Land-Based Anti-Ship Missile (LBASM) Technology

A. Mission Description and Budget Item Justification

This Project directly supports Long Range Precision Fires Modernization Priority capabilities by investigating and developing novel aerodynamic modeling and aerostructures to support extended range and maneuvering missile applications in high aerodynamic and thermal loading environments.

Work in this Project complements PE 0603464A (Long Range Precision Fires Advanced Technology) / Project AE8 (Land Based Anti-Ship Missile (LBASM) Advanced Tech, and Project AF2 Long Range Maneuverable Fires (LRMF) Advanced Tech.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Simulation and Aerostructures Technology	-	1.313	-
Description: Investigate and develop novel aerodynamic modeling and aerostructures to support extended range and maneuvering missile applications in high aerodynamic and thermal loading environments.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AF5 / *Simulation and Aerostructures Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will develop aero-structural-propulsion design and analysis tools for the design and optimization of very high speed missile airframes and air inlets operating in low density flows at high altitude. These tools are critical for the development of very high speed missile concepts and to guide the design of this class of missile systems. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY21 Funding realigned to PE 0602147A (Long Rang Precision Fires Technology)/Project AE7 (Land-Based Anti-Ship Missile Technology).			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.063	-
Accomplishments/Planned Programs Subtotals	-	1.376	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AF6 / *Structures Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AF6: *Structures Technology*	-	0.000	1.195	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.195

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602303A Missile Technology:
* Project 214 Missile Technology

In FY21 this Project is realigned to:
PE 0602147A Long Rang Precision Fires Technology:
* Project AE7 Land-Based Anti-Ship Missile (LBASM) Technology

A. Mission Description and Budget Item Justification

This Project directly supports Long Range Precision Fires Modernization Priority capabilities by investigating advanced materials supporting survivable, high-speed missiles and identifying approaches of to reduce weight and size of missile structures using advanced materials and manufacturing techniques.

Work in this Project complements PE 0603464/AE8 LBASM Advanced Technology; PE 0602147/AF1 LRMF Technology, and PE 0603464/AF2 LRMF Advanced Technology.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Structures Technology	-	1.140	-
Description: Investigate advanced materials supporting survivable, high-speed missiles; identify approaches of for reducing weight and size of missile structures using advanced materials and manufacturing techniques.			
FY 2020 Plans: Will continue to investigate, analyze and design high temperature, high- strength materials for structural airframe and conformal radio frequency and imaging infrared window/dome applications for high flight speed missile applications.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AF6 / *Structures Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2021 funding realigned to PE 0602147A (Long Rang Precision Fires Technology)/Project AE7 (Land-Based Anti-Ship Missile Technology).			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.055	-
Accomplishments/Planned Programs Subtotals	-	1.195	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AF7 / *Warhead Integration Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AF7: *Warhead Integration Technology*	-	0.000	1.681	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.681

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602303A Missile Technology:
* Project 214 Missile Technology

In FY21 this Project is realigned to:
PE 0602147A Long Rang Precision Fires Technology:
* Project AE7 Land-Based Anti-Ship Missile (LBASM) Technology

A. Mission Description and Budget Item Justification

This Project directly supports Long Range Precision Fires Modernization Priority capabilities by investigating advanced warhead subsystem integration techniques for future missile systems.

Work in this Project complements PE 0603464A (Long Range Precision Fires Advanced Technology) / AE8 (Land-Based Anti-Ship Missile (LBASM) Advanced Tech); PE 0602147A (Long Range Precision Fires Technology) / AF1 (Long Range Maneuverable Fires (LRMF) Technology) and PE 0603464A (Long Range Precision Fires Advanced Technology) / AF2 (Long Range Maneuverable Fires (LRMF) Advanced Tech)

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Warhead Integration Technology	-	1.605	-
Description: Investigate advanced warhead subsystem integration techniques for future missile systems.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AF7 / *Warhead Integration Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will complete development of a multi-role lethality for multi-role systems analysis tool to be used to predict probability of kill for multiple-purpose warhead configurations against cross-domain targets. Will investigate and design multi-effects warhead and fuze component technologies for very high speed missile terminal target engagement. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Beginning in FY21, this effort realigned to Project AE7 Land Based Anti-Ship Missile Technology within this PE.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.076	-
Accomplishments/Planned Programs Subtotals	-	1.681	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AF8 / *Affordable Extended Range Precision Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AF8: *Affordable Extended Range Precision Technology*	-	0.000	0.288	8.491	-	8.491	8.792	9.391	9.623	8.850	0.000	45.435

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602303A Missile Technology:
*Project 214 Missile Technology

A. Mission Description and Budget Item Justification

This Project directly supports Long Range Precision Fires Modernization Priority capabilities by investigating the design and fabrication of components and subsystems critical to produce affordable extended range precision missiles as well as critical component technologies including: advanced propulsion, seekers/sensors, fire control, datalink, guidance, navigation and controls, airframes, and additional high payoff areas.

Work in this Project complements PE 0603464A (Long Range Precision Fires Advanced Technology) / AE8 (Land-Based Anti-Ship Missile (LBASM) Advanced Tech); PE 0602147A (Long Range Precision Fires Technology) / AF1 (Long Range Maneuverable Fires (LRMF) Technology) and PE 0603464A (Long Range Precision Fires Advanced Technology) / AF2 (Long Range Maneuverable Fires (LRMF) Advanced Tech)

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Affordable Extended Range Precision Technology	-	0.275	-
Description: Investigate the design and fabrication of components and subsystems critical to produce affordable extended range precision missiles; Critical component technologies including: advanced propulsion, seekers/sensors, fire control, datalink, guidance, navigation and controls, and airframes.			
FY 2020 Plans: Will complete trade studies for affordable discriminate extended range precision missiles for long-range indirect fires capabilities.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AF8 / *Affordable Extended Range Precision Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
In FY21, research efforts area are being realigned to the Long Range Precision Fires (LRPF) High Payoff Missile Technology effort within this Project.			
Title: LRPF High Payoff Missile Technology ***Description:*** Identify and explore potential breakthrough technologies to mitigate or eliminate warfighter gaps in Long Range Precision Fires to gain overmatch against potential peer and near-peer adversaries. ***FY 2021 Plans:*** Will analyze and develop integrated board level sensor-on-a-chip utilizing advanced thermal management techniques to improve signal processing and reduce size and weight of future missile seekers; will investigate advanced materials modeling/optimization techniques and emerging high temperature materials to reduce weight and further extend the range of long range missiles; will investigate advanced navigation and alternate navigation approaches that greatly reduce or eliminate the need for GPS for precision guidance of long range missiles in contested environments; and will research long range, low altitude datalink technologies and communication architectures. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increase to advance critical technologies required for future missile efforts in the Long Range Precision Fires Army Modernization Priority area.	-	-	8.491
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.013	-
Accomplishments/Planned Programs Subtotals	-	0.288	8.491

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army												Date: February 2020
Appropriation/Budget Activity 2040 / 2					**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*				**Project (Number/Name)** AF9 / *Precision and Accuracy Technology*			
COST ($ in Millions)	**Prior Years**	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**	**FY 2022**	**FY 2023**	**FY 2024**	**FY 2025**	**Cost To Complete**	**Total Cost**
AF9: *Precision and Accuracy Technology*	-	0.000	8.230	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	8.230

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602303A Missile Technology:
* Project 214 Missile Technology

In FY21 this Project is realigned to:
PE 0602147A Long Rang Precision Fires Technology:
* Project AE7 Land-Based Anti-Ship Missile (LBASM) Technology

A. Mission Description and Budget Item Justification

This Project directly supports Long Range Precision Fires Modernization Priority capabilities by investigating and developing advanced missile seekers, sensors, and software/algorithms to increase affordability and performance of missiles for precision at extended ranges. This Project also investigates and develops advanced technologies for effective guidance and navigation of precision missiles through unique navigation technologies and algorithms aimed at reducing size, weight, power and cost.

Work in this Project complements PE 0603464A / AE8 (Land-Based Anti-Ship Missile Advanced Technology)

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

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

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2019**	**FY 2020**	**FY 2021**
Title: Precision and Accuracy Technology	-	7.856	-
Description: Investigate and develop advanced missile seekers, sensors, and software/algorithms to increase affordability and performance of missiles for precision at extended ranges. This effort investigates and develops advanced technologies for effective guidance and navigation of precision missiles through unique navigation technologies and algorithms aimed at reducing size, weight, power and cost.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AF9 / *Precision and Accuracy Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will investigate and develop advanced radio frequency and infrared sensor; target acquisition, discrimination, and classification algorithms and processes; and guidance technologies that: reduce size, weight, and power; decrease processing time; lower cost; increase target acquisition range; and ensure accurate long range, high speed missile target engagement in a jammed and complex operating environment; Will investigate and develop advanced position, navigation, and timing technologies, including: improved performance inertial measurement technology with reduced size, weight, power, and cost; celestial navigation technology; and vision based technology that ensures accurate long range, high speed missile target engagement in jammed and complex operating environments. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Beginning in FY21 this effort is realigned to Project AE7 Land-Based Anti-Ship Missile Technology within this PE.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.374	-
Accomplishments/Planned Programs Subtotals	-	8.230	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AG1 / *Missile Electronics Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AG1: *Missile Electronics Technology*	-	0.000	3.021	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.021

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602303A Missile Technology:
* Project 214 Missile Technology

In FY21 this Project is realigned to:
PE 0602147A Long Rang Precision Fires Technology:
* Project AE7 Land-Based Anti-Ship Missile (LBASM) Technology

A. Mission Description and Budget Item Justification

This Project directly supports Long Range Precision Fires Modernization Priority capabilities by investigating and developing technologies and techniques to miniaturize guidance electronics for advanced missile systems.

Work in this Project complements PE 0602147A (Long Range Precision Fires Technology) and PE 0603464A (Long Range Precision Fires Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Missile Electronics Technology	-	2.884	-
Description: Investigates and develops technologies and techniques to miniaturize guidance electronics for advanced missile			
FY 2020 Plans: Will investigate and develop advanced thermal management techniques; electronics wire bonding fabrication and assembly techniques; and battery chemistry optimization and high yield energy harvesting technologies for reduced size, weight, and power of multi-mode sensors for cross-domain target acquisition, discrimination and engagement.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AG1 / *Missile Electronics Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Beginning in FY21 this effort is realigned to Project AE7 Land-Based Anti-Ship Missile Technology within this PE.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.137	-
Accomplishments/Planned Programs Subtotals	-	3.021	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AG2 / *Information and Signal Processing Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AG2: *Information and Signal Processing Technology*	-	0.000	1.602	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.602

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602303A Missile Technology:
* Project 214 Missile Technology

In FY21 this Project is realigned to:
PE 0602147A Long Rang Precision Fires Technology:
* Project AE7 Land-Based Anti-Ship Missile (LBASM) Technology

A. Mission Description and Budget Item Justification

This Project directly supports Long Range Precision Fires Modernization Priority capabilities by investigating and developing image processing technologies and techniques for enhanced target acquisition and engagement and investigating improved secure, digital missile communication with ground and other systems.

Work in this Project complements PE 0602147A (Long Range Precision Fires Technology) and PE 0603464A (Long Range Precision Fires Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Information and Signal Processing Technology	-	1.529	-
Description: This effort investigates and develops image processing technologies and techniques for enhanced target acquisition and engagement and investigates improved secure, digital missile communication with ground and other systems.			
FY 2020 Plans: Will continue to investigate and develop advanced algorithms and signal processing techniques for enhanced target acquisition and engagement in contested and complex anti-access / area-denial (A2/AD) environments.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AG2 / *Information and Signal Processing Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Beginning in FY21 this effort is realigned to Project AE7 Land-Based Anti-Ship Missile Technology within this PE.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.073	-
Accomplishments/Planned Programs Subtotals	-	1.602	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AG4 / *Extended Range Artillery Munition Suite Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AG4: *Extended Range Artillery Munition Suite Technology*	-	0.000	6.806	8.667	-	8.667	11.889	12.126	13.572	14.490	0.000	67.550

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602624 Weapons and Munitions Technology
* Project H18 Weapons and Munitions Technologies

A. Mission Description and Budget Item Justification

This Project directly supports Long Range Precision Fires Modernization Priority capabilities by investigating critical enabling component technologies and designing high precision terminal guidance in denied environments, capable of surviving high gun shock loads, at extended ranges, and automated cannon artillery technologies to increase operational tempo and unburden the soldier.

Work in this Project complements PE 0603464A Long Range Precision Fires Advanced Technology / AG5 (Extended Range Artillery Munition Suite Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Precision At Range Technologies	-	2.794	3.151
Description: Investigates technologies that provide affordable precision capabilities for projectiles fired into Global Positioning System (GPS) denied environments.			
FY 2020 Plans: Will assess component level enabling technologies for passive seekers to include Infrared (IR) focal plane arrays and associated optics capable of surviving gun shock loading and perform as required. In addition to the terminal seeker hardware development activities, target detection algorithm as well performance modeling of such algorithms will be conducted in support of the terminal seeker development for Extended Range Artillery Projectiles (e.g. XM1155).			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AG4 / *Extended Range Artillery Munition Suite Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will investigate critical passive seeker component technologies, including IR focal plane arrays and associated optics, for viability of operation in anticipated gun shock loading environments; develop terminal seeker component hardware for future integration with extended range artillery munitions; investigate target detection algorithms for terminal seeker development for extended range munitions (e.g. XM1155); conduct component level experiments to validate modeled performance through captive flight testing; design and develop component technologies to provide increased range, sensor optimization, improved algorithms and refined guidance and navigation system design concepts for future artillery munitions. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Extended Range Artillery Munition Suite Enabling Technologies ***Description:*** This effort develops, matures and integrates a gun hardened suite of components (software, sensors, navigation and communications) to enable the application of distributed, cooperative and collaborative tactics for munitions and Radio Frequency (RF) seeking components. ***FY 2020 Plans:*** Will design and develop component technologies for extended range artillery projectiles (e.g. XM1155) in the areas of increased range, sensor optimization, improved algorithms and refined guidance and navigation system design concepts. ***FY 2021 Plans:*** Will mature component technologies for extended range artillery projectiles (e.g. XM1155) through improved algorithms and refined guidance and navigation system design concepts; conduct component level experiments to validate modeled performance; determine relevant conditions to enable intra-munition communications, enhancing probability of kill ratios and increasing effectiveness against targets in highly cluttered environments. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding realigned to focus on Optionally Manned Artillery Platform Technology	-	3.703	1.997
Title: Optionally Manned Artillery Platform Technology ***Description:*** This effort designs and develops cannon artillery automation technologies including automated fuze/fuze setting technologies, automated prognostics/diagnostics, automated and rapid rearm technologies, and automated ammunition inventory to increase operational tempo of current and future cannon artillery systems to unburden the soldier ***FY 2021 Plans:*** Will investigate cannon artillery automation technologies; Will investigate automated fuze/fuze setting technologies to decrease fuze setting times and increase the rate of fire for precision projectiles; Will investigate automated prognostics/diagnostics to	-	-	3.519

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AG4 / *Extended Range Artillery Munition Suite Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
enable automated operations; Will investigate automated and rapid rearm technologies including automated ammunition inventory to decrease operational down-time and unburden the soldier. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increase to investige cannon artillery automation technologies			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.309	-
Accomplishments/Planned Programs Subtotals	-	6.806	8.667

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AG6 / *Energetic Materials and Advanced Processing Techno*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AG6: *Energetic Materials and Advanced Processing Techno*	-	0.000	6.607	3.430	-	3.430	3.511	3.581	0.000	0.000	0.000	17.129

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602624A Weapons and Munitions Technology:
* Project H18 Weapons and Munitions Technologies
* Project H28 Warheads/Energetics Technologies

A. Mission Description and Budget Item Justification

This Project directly supports Long Range Precision Fires Modernization Priority capabilities by investigating critical component technology of propellants and energetic materials to increase the range of artillery and mortar rocket assisted projectiles.

Work in this Project complements PE 0602141A (Lethality Technology) / AH9 (Advanced Warheads Technology) and PE 0603464A (Long Range Precision Fires Advanced Technology) / AG5 (Extended Range Artillery Munition Suite Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Novel Propulsion	-	3.163	-
Description: This effort explores propellant technologies such as powder co-extrusion and grain coatings, while retaining insensitive properties, for employment in gun launch environments as well as directional thrusters including those that deliver a broad spectrum of effects. It also conducts experiments with these propellants to increase the range of artillery and mortar rocket assisted projectiles.			
FY 2020 Plans: Will continue design and development of material synthesis and formulation to support development of encapsulated propellant; will investigate novel burn rate modifiers and enhancers in conjunction with high-energy propellant formulations; fund research to advance maturity of detonation based gun propulsion; conduct experiments and further development on configuration and			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AG6 / *Energetic Materials and Advanced Processing Techno*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
formulation of electrically controlled energetic materials (ECEM); fund research of next generation post launch propulsion on gun launched concepts for extended range. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding realigned to the Scale-up of Insensitive Energetic Materials effort within this Project.			
Title: Scale-up of Insensitive Energetic Materials ***Description:*** Conduct research to advance the maturity of disruptive energetic materials. ***FY 2020 Plans:*** Will develop modeling and simulation tools required for advanced energetic materials; will investigate the synthesis and fabrication of energetic materials that are applicable to a wide range of additive manufacturing processing technologies; design and develop new processing methods for of novel energetic materials in unique geometries; fund research to investigate embedded ignition for additively manufactured gun propulsion charges. ***FY 2021 Plans:*** Will design synthesis processes for the fabrication of energetic materials applicable to a wide range of additive manufacturing technologies; will design embedded ignition for additively manufactured gun propulsion charges; will conduct experiments of ECEM formulations; will investigate next generation post launch propulsion concepts to achieve extended range. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increase to support additional development and experiments of insensitive materials.	-	3.144	3.430
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.300	-
Accomplishments/Planned Programs Subtotals	-	6.607	3.430

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AG6 / *Energetic Materials and Advanced Processing Techno*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AG8 / *Advanced Energetics Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AG8: *Advanced Energetics Technology*	-	0.000	10.098	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	10.098

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602624A Weapons and Munitions Technology:
* Project H28 Warheads/Energetics Technology

In FY21 this Project is realigned to:
PE 0602141A Lethality Technology:
* Project AH9 Advanced Warheads Technology

A. Mission Description and Budget Item Justification

This Project directly supports Long Range Precision Fires Modernization Priority capabilities by investigating critical component technology of materials and novel processing techniques for future explosives and propulsion applications that enable an increase in range, lethality, and utility of ammunitions.

Work in this Project complements PE 0602141A (Lethality Technology) / AH9 (Advanced Warheads Technology), PE 0602147A (Long Range Precision Fires Technology) / AG6 (Energetic Materials and Advanced Processing Techno), and PE 0603464A (Long Range Precision Fires Advanced Technology) / AG7 (Energetic Materials and Adv Processing Adv Tech).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Advanced Energetics	-	9.639	-
Description: This effort develops advanced energetic materials and novel processing techniques for future explosives and propulsion applications that enable an increase in range, lethality, and utility of ammunitions.			
FY 2020 Plans: Will mature technologies focused in nano-energetics designs for use in melt-cast formulations; will mature the polymer kinetics for amorphous energetics; will investigate next-generation melt-cast and cast-cure ingredients for higher energy formulations; investigate reaction kinetics for ingredient synthesis applicable to advanced flow reactors; investigate energetic materials			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AG8 / *Advanced Energetics Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
applicable for novel energy release mechanisms; design and develop processing parameters necessary to produce energetic materials for additive manufacturing; develop novel modeling and simulation tools required to accurately predict energetic materials performance in novel and unique geometries. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Beginning in FY21, effort realigned under PE 0602141A (Lethality Technology) / AH9 (Advanced Warheads Technology).			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.459	-
Accomplishments/Planned Programs Subtotals	-	10.098	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AG9 / *Multiple Simul Engagement Technologies (MSET) Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AG9: *Multiple Simul Engagement Technologies (MSET) Tech*	-	0.000	2.062	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	2.062

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602303A Missile Technology
* Project 214 Missile Technology

In FY21 this Project is realigned to:
PE 0602148A Future Vertical Lift Technology
* Project AK4 Multi-Role Small Guided Missile Tech

A. Mission Description and Budget Item Justification

This Project directly supports Long Range Precision Fires Modernization Priority capabilities by investigating critical component technology and designs for future missiles that provide simultaneous multiple launch, control, and supervised autonomous terminal engagement of multiple missiles against stationary and moving hard/soft targets, image-based target discrimination/shared SA/lock-on, and multi-missile control digital datalink with inter-missile cooperative networked communications.

Work in this Project complements PE 0603464A (Long Range Precision Fires Advanced Technology) / AF4 (Missile Simulation Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Multiple Simultaneous Engagement Technologies (MSET) Technology	-	1.969	-
Description: Investigate critical component technology and designs for future missiles that provide simultaneous multiple launch, control, and supervised autonomous terminal engagement of multiple missiles against stationary and moving hard/soft targets, image-based target discrimination/shared situation awareness/lock-on, and multi-missile control digital datalink with inter-missile cooperative networked communications.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AG9 / *Multiple Simul Engagement Technologies (MSET) Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will develop missile MSET system architecture and user-validated concept of operations, and conduct technology and component trade studies. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Beginning in FY21, effort under PE 0602148A Future Vertical Lift Technology / Project AK4 Multi-Role Small Guided Missile Tech.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.093	-
Accomplishments/Planned Programs Subtotals	-	2.062	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AH2 / *Single Multi-mission Attack Missile (SMAM) Technol*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AH2: *Single Multi-mission Attack Missile (SMAM) Technol*	-	0.000	1.264	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.264

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602303A Missile Technology
* Project 214 Missile Technology

In FY21, this Project is Eliminated.

A. Mission Description and Budget Item Justification

This Project directly supports Long Range Precision Fires Modernization Priority capabilities by investigating critical component technology and designs for future missiles that provide expeditionary, scalable, precision strike and loiter capability to rapidly defeat hard targets and swarming or disbursed threats; Provides the missile technology path to supervised autonomous target detection and cooperative engagement/manned-unmanned teaming for offensive, multiple simultaneous engagement capabilities.

Work in this Project complements PE 0603464A (Long Range Precision Fires Advanced Technology) / AH3 (Single Multi-mission Attack Missile Adv Tech) and PE 0603464 (Long Range Precision Fires Advanced Technology) / AH1 (Multiple Simultaneous Engagement Technologies (MSET) Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Single Multi-mission Attack Missile (SMAM) Technology	-	1.207	-
Description: This effort investigates critical component technology and designs for future missiles that provide expeditionary, scalable, precision strike and loiter capability to rapidly defeat hard targets and swarming or disbursed threats; Provides the missile technology path to supervised autonomous target detection and cooperative engagement/manned-unmanned teaming for offensive, multiple simultaneous engagement capabilities.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AH2 / *Single Multi-mission Attack Missile (SMAM) Technol*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will complete development and lab validation of radio module for extended range digital datalink with anti-jam capability to enable operation in contested environments. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Effort ends in FY 2020.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.057	-
Accomplishments/Planned Programs Subtotals	-	1.264	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AH4 / *Precision and Coop Weapons in a Denied Env Tech*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AH4: *Precision and Coop Weapons in a Denied Env Tech*	-	0.000	9.121	9.628	-	9.628	9.822	10.042	10.154	10.257	0.000	59.024

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 062618A Ballistics Technology:
* Project H80 Survivability and Lethality Technology

A. Mission Description and Budget Item Justification

This Project investigates technologies to deliver accurate fires from extended ranges in denied environments and informs future close- and deep-range Long Range Precision Fires capabilities (e.g., Extended Range Cannon Artillery, Precision Strike Missile). Work in this PE researches technologies for navigation of munitions without Global Positioning System (GPS) and flying munitions to much greater distances against advanced threat Area Denial Assets by delivering navigation technology for multiple munitions with complementary sensors and maneuverability technology for munitions with enhanced lift and control characteristics.

Work in this Project transitions foundational understating obtained in PE 0601102A (Defense Research Sciences) / AA7 (Mechanics and Ballistics) and complements PE 0602141A (Lethality Technology) / AH5 (Projectile and Multi-Function Warhead Technologies), Project AH6 (Disruptive Energetics and Propulsion Technologies), Project AH7 (Lethal and Scalable Effects Technologies), and Project AH8 (Lethality Materials and Processes Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Munition Navigation Technology in Contested Environments	-	4.601	5.095
Description: This effort investigates, designs, and transitions technologies to improve navigation (e.g., better accuracy, more information/aim-point refinement, reduce GPS dependency) of munitions subject to denied environments (e.g., electro-magnetic spectrum contested, counter-measures). Key technologies include algorithms for image processing, state estimation, and communications, embedded processing and electronics, and sensors (e.g., inertial, imagers with optics, software-defined radios and antennae). ***FY 2020 Plans:*** Will demonstrate technologies for improved navigation in gun firings with open-loop maneuvers; will develop data-driven and model-based image processing, state estimation, and communications algorithms in simulation and verify implementation in			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AH4 / *Precision and Coop Weapons in a Denied Env Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
common software/hardware-in-the-loop environment; Design guidance electronics with apertures, characterize static and dynamic performance, and validate mechanical/thermal survivability in lab. ***FY 2021 Plans:*** Will design collaborative navigation and guidance algorithms with improved realism of collaborative munitions engagement modeling and simulation; will develop sensor fusion state estimation and machine learning algorithms for object detection using image databases on real-time processors to provide mid-course navigation and terminal guidance in contested environments; will validate mid-course and terminal guidance technologies during cannon-launched Global Positioning System -guided flights characteristic of future Long Range Precision Fires missions. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Munition Maneuvering Technology in Extreme Environments ***Description:*** This effort investigates and designs technologies to improve maneuverability (e.g., extended range glide, intercept moving target, course- correct to imperfectly located target, perform evasive terminal maneuver to increase survivability) of munitions subject to extreme environments (set- back, set-forward, and balloting loads encountered during gun launch and thermal loads encountered during high speed/long time flights). These technologies include the maneuvering airframe, control actuation, and flight control algorithms. ***FY 2020 Plans:*** Will demonstrate technologies for increased range/lateral acceleration in gun firings with open-loop maneuvers; will perform un/coupled fluid dynamics, heat transfer, structural dynamics, flight dynamics and control computations validated by spark range and onboard sensor flights; Develop flight control algorithms for automating flight conditions and configurations and assess flight performance in simulation; Design control actuation, characterize static and dynamic performance, and validate mechanical/thermal survivability in lab and verify flight control and control actuation implementation in common software/hardware-in-the-loop environment. ***FY 2021 Plans:*** Will design munition guidance algorithms and required system characteristics to improve terminal survivability against integrated air defense system targets; will design model-based optimal flight control automation to reduce gain tuning cycle time; will develop aerodynamic control actuation with increased hinge loads, rise time/delay, packaging, and launch survivability; will design airframe flight characterization and design tools to improve accuracy and shorten design cycle time; will validate airframe, control actuation,	-	4.105	4.533

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** AH4 / *Precision and Coop Weapons in a Denied Env Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
and flight control technologies during cannon-launched GPS guided flights characteristic of future Long Range Precision Fires missions. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.415	-
Accomplishments/Planned Programs Subtotals	-	9.121	9.628

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army												Date: February 2020
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602147A / *Long Range Precision Fires Technology*				Project (Number/Name) BN5 / *Fuze and Power for Munitions*			
COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BN5: *Fuze and Power for Munitions*	-	0.000	0.960	1.065	-	1.065	2.615	2.667	2.696	2.723	0.000	12.726

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602624A Weapons and Munition Technology:
* Project H18 Weapons and Munitions Technologies

A. Mission Description and Budget Item Justification

This Project directly supports Long Range Precision Fires Modernization Priority capabilities by investigating critical component technologies and designs capable to enable advanced lethality and scalable warheads for future munitions as well as exploring new power technologies for extended run time and extended range munitions.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Advanced Energetics	-	0.917	1.065

Description: This effort develops advanced fuze and power technologies for future munition applications that enable an increase in range and lethality, of ammunitions.

FY 2020 Plans:
Will advance the capability of state of the art in fuze proximity sensors to track targets in order to improve burst point accuracy and countermeasure robustness; will maximize usage of all real time battlefield targeting data and integrate with fuze setters, fuze sensors, power sources, component protective technologies and unique fuze ignition schemes to design and develop extremely reliable and versatile fuzes; will investigate these new fuze designs to support hypersonics, autonomous fuzing for varied targets including Unmanned Aerial Systems. These technologies will continue to leverage the Office of the Secretary of Defense (OSD) Joint Munitions Program TCG - 5 and TCG-10 and the OSD Joint Fuze Technology Program.

FY 2021 Plans:
Will investigate enabling technologies for improved lethality in munition applications while ensuring operation during extended range flight; will develop algorithms and explore advance capabilities for fuze proximity sensors to track targets and resist countermeasures; will conduct component level experiments for breadboard design architectures of of electronic safe and

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** BN5 / *Fuze and Power for Munitions*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
arm device; will design interfaces for secure wireless data setting in advanced auto-loader systems; will investigate wireless technology protocols to enable high speed data transfer; will investigate novel power approaches for long range munitions and hypersonics technologies. This effort will continue to leverage the OSD Joint Munitions Program TCG-5 and TCG-10 and the OSD Joint Fuze Technology Program. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.043	-
Accomplishments/Planned Programs Subtotals	-	0.960	1.065

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** BO9 / *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE (CA)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BO9: *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE (CA)*	-	0.000	49.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	49.000

Note

Congressional Interest Item funding provided for Weapons and Munitions Tech Program Initiative.

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Weapons and Munitions Tech Program Initiative.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Composite Cannon Tubes and Propulsion Technology ***FY 2020 Plans:*** Composite Cannon Tubes and Propulsion Technology	-	10.000
Congressional Add: Hybrid Projectile Technology ***FY 2020 Plans:*** Hybrid Projectile Technology	-	6.000
Congressional Add: Additive Manufacturing to Support Optimized Fires ***FY 2020 Plans:*** Additive Manufacturing to Support Optimized Fires	-	5.000
Congressional Add: Program Increase ***FY 2020 Plans:*** Program Increase	-	20.000
Congressional Add: Novel Printed Armament Components ***FY 2020 Plans:*** Novel Printed Armament Components	-	8.000
Congressional Adds Subtotals	-	49.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602147A / *Long Range Precision Fires Technology*	**Project (Number/Name)** BO9 / *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE (CA)*

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	0.000	98.359	96.484	-	96.484	96.734	85.121	85.418	85.737	0.000	547.853
AI5: *Next Gen Tactical UAS TD Technology*	-	0.000	0.000	7.569	-	7.569	7.661	8.226	8.332	8.333	0.000	40.121
AI7: *Alternative Concept Engine Technology*	-	0.000	3.657	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.657
AI9: *Future UAS Engine Technology*	-	0.000	2.888	3.051	-	3.051	3.224	3.369	3.484	3.519	0.000	19.535
AJ2: *Next Generation Rotorcraft Transmission Technology*	-	0.000	4.045	4.122	-	4.122	4.205	1.449	1.465	1.465	0.000	16.751
AJ4: *Digital Vehicle Management and Control Technology*	-	0.000	4.816	6.458	-	6.458	6.587	5.720	4.796	4.796	0.000	33.173
AJ6: *Advanced Rotors Technology*	-	0.000	2.362	2.420	-	2.420	2.478	2.530	2.533	2.558	0.000	14.881
AJ8: *Experimental and Computational Aeromechanics Techn*	-	0.000	5.185	5.269	-	5.269	6.211	6.450	6.625	6.691	0.000	36.431
AK1: *UAS Survivability Technology*	-	0.000	1.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.000
AK2: *Aviation Survivability Technology*	-	0.000	21.792	21.233	-	21.233	22.113	21.545	21.799	21.801	0.000	130.283
AK4: *Multi-Role Small Guided Missile Technology*	-	0.000	6.104	7.692	-	7.692	8.418	0.000	0.000	0.000	0.000	22.214
AK6: *Advanced Rotorcraft Armaments Protection System Te*	-	0.000	5.313	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.313
AK9: *Adv Teaming for Tactical Aviation Operations Tech*	-	0.000	13.583	13.764	-	13.764	12.416	12.439	12.604	12.730	0.000	77.536

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army												Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*							
AL2: *High Performance Computing for Rotorcraft App Tech*	-	0.000	1.169	1.191	-	1.191	1.215	1.239	1.253	1.266	0.000	7.333
AL4: *High Speed and Efficient VTOL Vehicle Technology*	-	0.000	1.500	1.499	-	1.499	1.499	1.529	1.546	1.546	0.000	9.119
AL5: *Air Vehicle Structures and Dynamics Technology*	-	0.000	2.766	2.824	-	2.824	2.887	2.945	2.978	3.008	0.000	17.408
AL8: *Holistic Situational Awareness and Dec Making Tech*	-	0.000	1.745	1.783	-	1.783	1.819	1.855	1.877	1.896	0.000	10.975
AM2: *Aircraft and Aircrew Protection Technology*	-	0.000	1.522	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.522
AM4: *Opt Energy Stg & Therm Mgmt for FVL Survivability*	-	0.000	4.912	8.674	-	8.674	7.356	7.533	7.634	7.635	0.000	43.744
BP7: *Future Vertical Lift Air Platform Tech (CA)*	-	0.000	14.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	14.000
BZ7: *Future Vertical Lift Medical Technologies*	-	0.000	0.000	8.211	-	8.211	8.195	8.292	8.492	8.493	0.000	41.683
CC3: *FVL Radar Technologies*	-	0.000	0.000	0.724	-	0.724	0.450	0.000	0.000	0.000	0.000	1.174

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is realigned with continuity of effort from the following PEs:
* PE 0602120A Sensors and Electronic Survivability
* PE 0602211A Aviation Technology
* PE 0602270A Electronic Warfare Technology
* PE 0602303A Missile Technology
* PE 0602624A Weapons and Munitions Technology
* PE 0602705A Electronics and Electronic Devices
* PE 0602709A Night Vision Technology

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	**Date:** February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*

A. Mission Description and Budget Item Justification

This PE conducts air vehicle and mission system component design, fabrication, and evaluation to enable Army Future Vertical Lift. Emphasis is on developing aviation platform and mission system technologies to enhance manned and unmanned air vehicle combat and combat support operations for attack, reconnaissance, air assault, survivability, logistics, and command and control missions.

Work in this PE contributes to the Army Science and Technology (S&T) air systems portfolio and is fully coordinated with efforts in PE 0603465A (Future Vertical Lift Advanced Technology Development).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering S&T focus areas and the Army Modernization Strategy.
Work in this PE is performed by the United States Army Futures Command (AFC) and the Army Engineering Research and Development Center (ERDC).

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

B. Program Change Summary ($ in Millions)	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**
Previous President's Budget	0.000	93.601	88.903	-	88.903
Current President's Budget	0.000	98.359	96.484	-	96.484
Total Adjustments	0.000	4.758	7.581	-	7.581
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-9.242			
• Congressional Rescissions	-	-			
• Congressional Adds	-	14.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	7.581	-	7.581

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2019**	**FY 2020**
Project: BP7: *Future Vertical Lift Air Platform Tech (CA)*		
Congressional Add: *Flight Control Technology Safety and Survivability*	-	3.000
Congressional Add: *Rotary Wing Adaptive Flight Control Technology*	-	6.000
Congressional Add: *Technology Transfer and Innovation*	-	5.000
Congressional Add Subtotals for Project: BP7	-	14.000
Congressional Add Totals for all Projects	-	14.000

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AI5 / *Next Gen Tactical UAS TD Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AI5: *Next Gen Tactical UAS TD Technology*	-	0.000	0.000	7.569	-	7.569	7.661	8.226	8.332	8.333	0.000	40.121

Note

Funding in this Project was realigned from:
Program Element (PE) 0602211A Aviation Technology
* Project 47A Aeron & ACFT Wpns Tech

The FY20 funding requested in this Project was Marked in the FY20 Appropriation Conference Report.

A. Mission Description and Budget Item Justification

This Project utilizes improved computer modeling fidelity to investigate the effects that potential Future Unmanned Aircraft System (FUAS) capabilities could have on air vehicle design considerations and operational concepts. This project improves government capability to design and assess novel Unmanned Aircraft System (UAS) concepts . This Project develops and investigates the ability to launch a UAS from a manned or unmanned future vertical lift aircraft at tactical altitudes and to control the UAS from the cockpit or a crew station. This Project will assess the enabled capabilities and determine their relevance to current Army Aviation engagement and survivability portfolios.

Work in this Project is fully coordinated with PE 0603465A (Future Vertical Lift Advanced Technology Development).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Systems Concepts Studies for Air Launched Effects	-	-	7.569
Description: Investigates and models air vehicle concepts to understand the effects that potential operational Air Launched Effects capabilities will have on air vehicle properties.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AI5 / *Next Gen Tactical UAS TD Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will investigate and model the effect that overwatch, decoy, and electronic warfare capabilities will have on unmanned air vehicle designs including size, weight, system performance, power, survivability, and unit cost; will develop and assess concept air and ground launch vehicle designs to support reconnaissance, surveillance, electronic warfare, and lethal attack. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY21 funding increase in this Project results from Congressional language that eliminated Next Gen Tactical Unmanned Aircraft System (UAS) funding in FY20.			
Accomplishments/Planned Programs Subtotals	-	-	7.569

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AI7 / *Alternative Concept Engine Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AI7: *Alternative Concept Engine Technology*	-	0.000	3.657	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.657

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602211A Aviation Technology:
* Project 47A Aeron & ACFT Wpns Tech

In FY21 this Project is realigned to:
PE 0602148A Future Verticle Lift Technology
* Project AM4 Opt Energy Stg & Therm Mgmt for FVL Survivability

A. Mission Description and Budget Item Justification

This Project develops Future Vertical Lift (FVL) engine component technologies that could significantly improve platform performance, reliability, and operational capability.

Work in this Project is fully coordinated with PE 0603465A (Future Vertical Lift Advanced Technology Development).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Alternative Concept Engine Technology	-	3.491	-
Description: Design and evaluate advanced turboshaft engine component technologies to support goals of reduced fuel consumption, engine size, weight, and cost, as well as improved reliability and maintainability.			
FY 2020 Plans: Alternative concept engine component development will be completed by validating compressor, combustor and turbine technology.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AI7 / *Alternative Concept Engine Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
In FY21, this Project is realigned to PE 0602148A (Future Vertical Lift Technology) / AM4 (Opt Energy Stg & Therm Mgmt for FVL Survivability).			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.166	-
Accomplishments/Planned Programs Subtotals	-	3.657	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AI9 / *Future UAS Engine Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AI9: *Future UAS Engine Technology*	-	0.000	2.888	3.051	-	3.051	3.224	3.369	3.484	3.519	0.000	19.535

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602211A Aviation Technology:
* Project 47B Veh Prop & Struct Tech

A. Mission Description and Budget Item Justification

This Project designs and evaluates current and Future Unmanned Aircraft Systems (FUAS) advanced engine/power system component technologies to support the goals of multi-fuel capability, reduced fuel consumption, engine size, weight, and cost, as well as improved reliability, survivability, and maintainability.

Work in this Project is fully coordinated with PE 0603465A (Future Vertical Lift Advanced Technology Development).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Multi-fuel Capable Hybrid Electric Propulsion	-	2.757	3.051
Description: Applied research to enable intelligent and robust propulsion performance and noise signature reduction via multi-fuel and optimized hybrid electric capability for small engines (20kW to 150kW) powering future aircraft systems. The research focuses on the establishment of concepts to enable reduced fuel consumption, engine size, weight, and cost as well as improved group 3 and 4 FUAS reliability, survivability, and maintainability.			
FY 2020 Plans: Will establish research in assisted ignition technology and explore methodologies for robust combustion control. Will initiate research in hybrid-electric component optimization, thermal management analysis, advanced radial turbomachinery assessment, and additive-manufacturing for turbomachinery and high-temperature reaction chamber components.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AI9 / *Future UAS Engine Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will design and develop robust energy assistance probe and controls, and real-time fuel property detection technology. The energy assistance probe will assist with combustion instability derived from low ignition quality fuels. Will validate improved turbocharger designs to minimize identified resonances and thrust oil-less bearing. Will investigate thermal and power management module in the hybrid-electric tool for the optimization and integration of engine power plants and high-performance electric machines to enable efficient delivery and management of power in Army unmanned air vehicles. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.131	-
Accomplishments/Planned Programs Subtotals	-	2.888	3.051

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AJ2 / *Next Generation Rotorcraft Transmission Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AJ2: *Next Generation Rotorcraft Transmission Technology*	-	0.000	4.045	4.122	-	4.122	4.205	1.449	1.465	1.465	0.000	16.751

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602211A Aviation Technology
* Project 47A Aeron & ACFT Wpns Tech.

A. Mission Description and Budget Item Justification

This Project investigates Future Vertical Lift (FVL) advanced drive train technologies that increase performance and double current drivetrain life cycles while improving their reliability and maintainability.

Work in this Project is fully coordinated with PE 0603465A (Future Vertical Lift Advanced Technology Development).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Next Generation Rotorcraft Transmission Technology	-	3.862	-
Description: Design and evaluate advanced drive system component technologies to support Variable multi-speed (50-100%), while doubling current transmission life cycles and improving platform reliability and maintainability. ***FY 2020 Plans:*** Will investigate innovative methods to achieve variable speed such as elliptical drive technologies. Variable speed component fabrication and testing will be completed. This effort will inform a full transmission demonstrator for FVL. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort is realigned to the High Reduction Ratio Transmission (HRT) Components effort in this Project.			
Title: High Reduction Ratio Transmission Components	-	-	4.122

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AJ2 / *Next Generation Rotorcraft Transmission Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: Effort investigates advanced materials and component designs that allow a 60:1 reduction ratio two-stage gearbox design that provides significant weight and volume reduction for extended range and component life for manned and unmanned applications. ***FY 2021 Plans:*** Will investigate new materials that allow higher contact stresses to enable high-reduction ratio gears that operate at high speeds. Will use the materials selected for development of component designs for HRT. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding for this effort is realigned in FY21 from Next Generation Rotorcraft Transmission Technology effort in this Project.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.183	-
Accomplishments/Planned Programs Subtotals	-	4.045	4.122

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AJ4 / *Digital Vehicle Management and Control Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AJ4: *Digital Vehicle Management and Control Technology*	-	0.000	4.816	6.458	-	6.458	6.587	5.720	4.796	4.796	0.000	33.173

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602211A Aviation Technology:
* Project 47A Aeron & ACFT Wpns Tech

A. Mission Description and Budget Item Justification

This Project investigates potential manned Future Vertical Lift (FVL) and Future Unmanned Aircraft System (FUAS) fly-by-wire & fly-by-light rotor/flight control and autonomy for active rotor and compound concepts. It also investigates, matures, and harmonizes leap-ahead autonomy, structures, and controls technologies, concepts, and capabilities which enable combat mission success across the family of manned/unmanned FVL platforms.

Work in this Project is fully coordinated with PE 0603465A (Future Vertical Lift Advanced Technology Development).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Digital Vehicle Management & Control Technology	-	4.597	-
Description: Investigate manned and unmanned advanced rotor/flight control concepts and vehicle management technologies focused on advanced aircraft configurations and complex missions. This effort will develop handling qualities requirements, mature simulation and optimization methods, and support goals of improved robustness, reduced weight, and collaborative teaming of FVL and FUAS platforms.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AJ4 / *Digital Vehicle Management and Control Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will complete fabrication of hardware components and will complete development of software for a new Research Flight Control Computer Assembly and associated Test Bench and Ground Test Unit. Will begin installation and testing of this new hardware into the Rotorcraft Aircrew Concept Airborne Laboratory (RASCAL) development facility and into the RASCAL test aircraft. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This effort is realigned in FY21 to the Adaptive and Resilient Tactical Autonomy, Controls, and Structures (ARTACS) Tech effort in this Project.			
Title: Adaptive and Resilient Tactical Autonomy, Controls, and Structures Tech ***Description:*** Develop autonomy, controls, and structures technologies to ensure mission success for manned/unmanned, multiple capability set Future Vertical Lift platforms in the contested environment of multi-domain operations. ***FY 2021 Plans:*** Will develop structural dynamics analytical tool enhancements based on more accurate analytical prediction of rotorcraft internal structural loads. Will develop adaptive, weight-efficient structural concepts enabling on-the-fly configuration adaptation for near-optimal performance across various flight conditions. Will apply validated, full-flight-envelope simulation methods to Future Vertical Lift configurations. Will develop mission-adaptive and damage tolerant control technologies aimed at advanced configurations with redundant controls. Will develop agility and maneuverability criteria, response types, and mission task elements for high speed. Will improve the functionality and robustness of autonomy algorithms and develop machine-learning-augmented technologies to enhance autonomous and optionally piloted flight operations, including the preservation of vehicle and mission capability. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This effort is realigned in FY21 from PE 0602148 (Future Vertical Lift Technology) / AM2 (Aircraft and Aircrew Protection Technology) as well as the Digital Vehicle Management and Control Technology effort in this Project.	-	-	6.458
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.219	-
Accomplishments/Planned Programs Subtotals	-	4.816	6.458

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AJ4 / *Digital Vehicle Management and Control Technology*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AJ6 / *Advanced Rotors Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AJ6: *Advanced Rotors Technology*	-	0.000	2.362	2.420	-	2.420	2.478	2.530	2.533	2.558	0.000	14.881

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602211A Aviation Technology
* Project 47A Aeron & ACFT Wpns Tech.

A. Mission Description and Budget Item Justification

This Project investigates Future Vertical Lift (FVL) technologies that mature high speed and highly efficient rotor and hub system designs.

Work in this Project is fully coordinated with PE 0603465A (Future Vertical Lift Advanced Technology Development).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Advanced Rotors Technology	-	2.255	2.420
Description: Investigate advanced rotor blade and hub technologies to support goals of increased speed and reduced drag by developing low weight rotors and hub configurations that increase hover and cruise efficiency. ***FY 2020 Plans:*** Will conduct design trades studies and technology bench tests to start technology down-selection for integrated high speed, highly efficient rotor system. Will commence conceptual design studies of the rotor system. ***FY 2021 Plans:*** Will conduct individual blade control actuator performance and thermal management testing. Will investigate durability performance of Unmanned Aerial Systems (UAS) rotors to determine robustness ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer	-	0.107	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AJ6 / *Advanced Rotors Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	-	2.362	2.420

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AJ8 / *Experimental and Computational Aeromechanics Techn*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AJ8: *Experimental and Computational Aeromechanics Techn*	-	0.000	5.185	5.269	-	5.269	6.211	6.450	6.625	6.691	0.000	36.431

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602211A Aviation Technology
* Project 47A Aeron & ACFT Wpns Tech.

A. Mission Description and Budget Item Justification

This Project investigates new high fidelity computational methods to simulate aerodynamic effects and test methods of emerging rotorcraft lift technologies that could be incorporated into Future Vertical Lift (FVL) designs.

Work in this Project is fully coordinated with PE 0603465A (Future Vertical Lift Advanced Technology Development).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Experimental Aeromechanics for FVL	-	2.919	3.020
Description: Develop and explore new methods to simulate aerodynamic effects for future FVL configurations.			
FY 2020 Plans: Will continue experimental investigation of interactional aerodynamic phenomena affecting the flow field and performance of winged-compound configurations; will conduct experimental efforts aimed at extending the state of the art for flow measurement & diagnostics techniques such as blade deformation measurement using digital image correlation, wake flow field measurements using particle image velocimetry, and laminar-to-turbulent transition measurement using pioneering infra-red thermography techniques. Will examine interactional aerodynamic effects on of multi-rotor configurations.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AJ8 / *Experimental and Computational Aeromechanics Techn*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will leverage results from FY20 research to perform interactional aerodynamic investigation of winged-compound configurations incorporating auxiliary propulsion. Will investigate interactional aerodynamic effects of multi-rotor configurations. Will continue experimental efforts aimed at extending the state of the art for measurement & diagnostics techniques for rotor blade structural deformation using embedded sensor networks and digital image correlation, wake flow measurements using advanced optical techniques. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Computational Aeromechanics for FVL ***Description:*** Investigate experimental aeromechanics technologies and test methods for FVL. ***FY 2020 Plans:*** Will automate the computational workflows and problem setup for high-fidelity computations that simulate the aerodynamics and structural dynamics of future vertical lift systems. Will adapt high-fidelity computational simulations to improve accuracy and optimize their computational efficiency on new and emerging high-performance computer architectures. ***FY 2021 Plans:*** Will verify and validate high-fidelity computational tools for full-vehicle aeromechanics analysis of FVL rotorcraft engineering problems. Will use these computational tools to help reduce expensive and time-consuming flight testing to rectify unforeseen deficiencies in new FVL aircraft. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	2.030	2.249
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.236	-
Accomplishments/Planned Programs Subtotals	-	5.185	5.269

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AJ8 / *Experimental and Computational Aeromechanics Techn*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AK1 / *UAS Survivability Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AK1: *UAS Survivability Technology*	-	0.000	1.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.000

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602211A Aviation Technology
* Project 47A Aeron & ACFT Wpns Tech

In FY21 this Project is realigned to:
PE 0603465A Future Vertical Lift Advanced Technology
* Project AK3 Aviation Survivability Advanced Technology

A. Mission Description and Budget Item Justification

This Project investigates Future Unmanned Aircraft System (FUAS) with mission tailored survivability capabilities that enable operations in contested environments against future peer/near peer threats.

Work in this Project is fully coordinated with PE 0603465A (Future Vertical Lift Advanced Technology Development).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Unmanned Aerial Systems Survivability	-	0.954	-
Description: Investigate innovative methods to design FUAS with tailored signature management and enhanced survivability.			
FY 2020 Plans: Will perform trade studies for identification of FUAS specific susceptibility and vulnerability attributes. Will develop tailored signature management for FUAS applications missions; survivability-enhanced mission profiles; team-based survivability behaviors; and electronic warfare-resilient systems and architectures.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AK1 / *UAS Survivability Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Funding is realigned in FY21 to PE 0603465A (Aviation Advanced Technology) / AK3 (Aviation Survivability Advanced Technology) because technology is maturing faster than anticipated.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.046	-
Accomplishments/Planned Programs Subtotals	-	1.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AK2 / *Aviation Survivability Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AK2: *Aviation Survivability Technology*	-	0.000	21.792	21.233	-	21.233	22.113	21.545	21.799	21.801	0.000	130.283

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602211A Aviation Technology:
* Project 47A Aeron & ACFT Wpns Tech
PE 0602270A Electronic Warfare Technology:
* Project 906 Tactical Electronic Warfare Applied Research
PE 0602624A Weapons and Munitions Technology:
* Project H28 Warheads/Energetics Technology
PE 0602705A Electronics and Electronic Devices:
* Project H94 (Elec & Electronic Dev
PE 0602709A Night Vision Technology:
* Project H95 Night Vision and Electro-Optic Technology

A. Mission Description and Budget Item Justification

This Project investigates advanced technologies to reduce Future Vertical Lift (FVL) platform susceptibility and vulnerability to damage from guided and unguided threats, as well as technologies to defeat small arms, rocket and missile threats. It also investigates and develops an integrated team-based system of systems survivability approach for Integrated Air Defense Systems breaching through purpose driven mix of improved survivability situational awareness, signature management, vulnerability reduction, route and maneuver optimization, expendables, advanced sensors, and Electro-optical (EO) & Radio Frequency (RF) jamming across distributed platforms.

Work in this Project is fully coordinated with PE 0603465A (Future Vertical Lift Advanced Technology Development).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Signature Reduction for Advanced Threat	-	3.887	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AK2 / *Aviation Survivability Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: Investigate advanced technologies to reduce susceptibility and vulnerability of aircraft to damage from threats or accidents, as well as technologies to defeat small arms, rocket, and missile threats. ***FY 2020 Plans:*** Will complete an adaptive Infrared (IR) engine suppression system for FVL aircraft in an engine test cell to evaluate engine and IR suppression performance. Will develop signature management technologies. Will complete evaluation of holistic survivability technology solutions through integrated survivability assessment trade studies for FVL concept aircraft. Will complete the development of modeling and simulation tools to support survivability analysis against advanced threat systems. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 funding for this effort is realigned to the Advanced Survivability Concepts effort in this Project.			
Title: Cognitive Countermeasures Technology Development ***Description:*** This effort investigates and matures novel materials, components, and techniques to counter legacy and emerging threats to FVL platforms. Emphasis will be placed on technologies and approaches to enable a robust, holistic countermeasure capability for target defeat, regardless of threat characteristics or guidance mode. ***FY 2020 Plans:*** Will investigate spectral and temporal RF signatures associated with legacy and emerging threats, then will develop detection and identification algorithms based on the threat signatures; will investigate ultra-short pulse laser (USPL) detector photo bleaching phenomena and characterize fundamental temporal limits and necessary radiation requirements to produce saturation effects; will investigate novel rare earth-doped low-phonon laser materials; and will design and develop an in-band Midwave Infrared (MWIR) short-pulse laser source with surrogate-diode pumping to be used for direct defeat of unknown future threats. ***FY 2021 Plans:*** Will develop preliminary sensor model for detection of specific targets studied from FY18 - FY20 and validate its performance against select targets; characterize ultra-short pulse Laser Induced Direct Damage (LIDD) of optical materials and detectors for physical and electronic damage/disruption; investigate the previously developed (in FY20) in-band MWIR laser source with surrogate-diode pumping and conduct the required research and development towards major performance optimization. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	1.802	1.997
Title: Reconfigurable Transformational Optics/Task based Display ***Description:*** This effort will deliver reconfigurable micro- and nano-scale filtering devices enabling frequency agile multi-task sensors. This will permit enhanced survivability of the FVL platforms with restored visual overmatch in any (day/night)	-	5.955	5.283

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AK2 / *Aviation Survivability Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
environment. This will allow visual penetration of natural obscurants (e.g. brownout, white out) or custom man-made obscurants (e.g. engineered smokescreens) from a single sensor, as well as narrowband filtering for active imaging through obscurants. Improved detection and identification capability will result from filtering out scattered light and enabling 3-dimensional ranging through environmental obscurants. Wavelength agile imaging systems will be delivered that are capable of penetrating and imaging through a variety of obscurants and that are compatible with the FVL platforms. ***FY 2020 Plans:*** Will investigate tunable filter designs in the midwave and longwave infrared for simultaneous on/off filter switching between broad and narrow bands, and tunability of the filter center wavelength; will validate selected filter designs maintain sufficient throughput. Will model and measure pulsed infrared laser illumination and ranging sources that will be incorporated into filter designs. ***FY 2021 Plans:*** Will design and develop tunable filter designs in the midwave and longwave infrared for simultaneous on/off filter switching between broad and narrow bands, and tunability of the filter center wavelength. Will down select filter designs that maintain sufficient throughput. Will validate pulsed infrared laser illumination and ranging sources that will be incorporated into filter designs. Will design and develop new optical material design concepts to increase damage resistance and minimize lens count. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding decreased in FY21 to realign to EW Air Sensors / CM effort in this Project.			
Title: Multispectral Threat Warning and Countermeasures ***Description:*** This effort investigates and evaluates software and warning sensor/counter measure components to increase probability to detect and defeat current and evolving small arms and man-portable air defense system (MANPADS) type threats for FVL platforms using modeling and simulation (M&S) and hardware in the loop (HWIL) simulations. ***FY 2020 Plans:*** Will investigate tunable filter designs in the midwave and longwave infrared for simultaneous on/off filter switching between broad and narrow bands, and tunability of the filter center wavelength; will validate selected filter designs maintain sufficient throughput. Will model and measure pulsed infrared laser illumination and ranging sources that will be incorporated into filter designs. ***FY 2021 Plans:*** Will investigate the incorporation of distributed sensor data into the threat declaration algorithm; will assess the optimal combination of sensors to perform high detection of multiple classes of unexploited threats; will analyze impact of threat progression on measured performance. ***FY 2020 to FY 2021 Increase/Decrease Statement:***	-	6.856	0.997

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AK2 / *Aviation Survivability Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Funding decreased in FY21 to support EW Air Sensors/CM effort in this Project			
Title: Tunable Pyrotechnics Technologies ***Description:*** Develop and investigate technologies for nano, reactive, and advanced/novel materials to enable, customize and ? tune? a family of Countermeasure Decoys for FVL platforms. ***FY 2020 Plans:*** Will develop component technologies for the Dazzler Counter Measure to include new pyrotechnic formulations; will develop and modify Advanced Sensor Counter Measure (ASCM) formulations based on static and functional tests to assess viability of technology candidates; will investigate new counter measure designs in the electromagnetic (EM) spectrum to address emerging threats to the FVL platforms. ***FY 2021 Plans:*** Will investigate novel countermeasure designs and miniaturize component technologies for Radio Frequency performance in the EM spectrum to address emerging threats for current and future aviation platforms; develop and assess the performance of new pyrotechnic formulations for Advanced Seeker Countermeasures through static and functional experiments. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.	-	2.302	2.622
Title: Advanced Survivability Concepts ***Description:*** This effort will provide analysis of the rapidly evolving and emerging threat environment and impacts to FVL platforms. This effort will also provide advanced teaming algorithms for survivability. ***FY 2021 Plans:*** Define integrate team survivability capability requirements. Perform preliminary research on full spectrum susceptibility and vulnerability reduction technologies that enhance team based survivability. Begin investigation into team based algorithms and behaviors for survivability. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding for this effort is realigned in FY21 from the Signature Reduction for Advanced Threat effort in this Project	-	-	4.163
Title: EW Air Sensors / CM ***Description:*** This effort investigates and develops Electronic Warfare (EW) survivability technologies to enable the detection and defeat of advanced threats. It provides algorithms, sensors, and effectors that are robust to advanced threat characteristics and operate effectively across the distributed team of FVL aircraft.	-	-	6.171

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AK2 / *Aviation Survivability Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2021 Plans: Will research technical approaches to detect and defeat advanced threat characteristics; will develop technical design for detection and defeat technology incorporating advanced signal processing features; will create digital and hybrid hardware models of advanced sensor and countermeasure (CM) payload and analyze functionality. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding for this task is realigned in FY21 from Reconfigurable Transformational Optics/Task based Display effort in this Project.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.990	-
Accomplishments/Planned Programs Subtotals	-	21.792	21.233

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AK4 / *Multi-Role Small Guided Missile Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AK4: *Multi-Role Small Guided Missile Technology*	-	0.000	6.104	7.692	-	7.692	8.418	0.000	0.000	0.000	0.000	22.214

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602303A Missile Technology
* Project 214 Missile Technology.

A. Mission Description and Budget Item Justification

The Project investigates, designs, and evaluates modular missile component technologies compatible with Future Vertical Lift (FVL) and Future Unmanned Aircraft Systems (FUAS) aviation platforms in a Multi-Domain Battle/Cross-domain Maneuver operational environment. Also investigates critical component technologies and designs for future missiles that can be launched simultaneously, can operate autonomously and/or under human supervision, and can form advanced, cooperative teams to defeat one or more hard/soft targets which are stationary and/or moving.

Work in this Project is fully coordinated with PE 0603465A (Future Vertical Lift Advanced Technology Development).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Modular Missile Technology ***Description:*** Evaluate critical technology and designs components compatible with Manned and Unmanned Aviation environments to provide scalable and tailorable improved lethality. Provides open architecture external and internal interfaces. ***FY 2020 Plans:*** Will mature and validate modular missile technology subsystems and open system architecture and verify subsystem performance for the forward firing variant in bench-level and laboratory environments. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This effort completes in FY20.	-	1.565	-
Title: Multi-Role Guided Missile - Extended Range Technology	-	4.262	4.496

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AK4 / *Multi-Role Small Guided Missile Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: Design, integrate, and investigate critical technologies that provide an aviation and ground launched maneuverable, loitering missile capability with endurance to achieve extended ranges; a man-in-the-loop for situational awareness and targeting lethal effects against hard armor and other high-value targets; communications that are not easily detectable or jammed; and that are effective in a Multi-Domain Battle/Cross-domain Maneuver operational environment. ***FY 2020 Plans:*** Will investigate missile system level and aviation platform interface requirements and conduct trade studies. Determine missile FVL and FUAS design architecture to include integration of Single Multi-Mission Attack Missile (SMAM) critical components matured under FY20 PE 0603464A (Long Range Precision Fires Advanced Technology / Project AH3 (Single Multi-mission Attack Missile Adv Tech). ***FY 2021 Plans:*** Will develop form factors and interfaces for critical components including navigation sensors, warheads, fire control, and digital missile datalinks. Will complete preliminary integrated missile system design; will perform stand-alone experiments with component technology hardware and software to verify performance; will perform experiments to determine adequate operation in a lab environment. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle for this effort.			
Title: Multiple Simul Engagement Technologies (MSET) ***Description:*** Investigate critical missile and fire control component technologies and designs for future missiles that can be launched simultaneously, can operate autonomously and/or under human supervision, and can form advanced, cooperative teams to defeat one or more hard/soft targets which are stationary and/or moving ***FY 2021 Plans:*** Will perform detailed design of target detection and tracking algorithms, multi-missile communications datalink, and multi-missile command and control algorithms; will develop laboratory environment for component experimentation and perform investigations of component technical performance. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This effort is realigned in FY21 from PE 0602147A (Long Range Precision Fires Technology) / AG9 (Multiple Simul Engagement Technologies (MSET) Tech).	-	-	3.196
Title: FY 2020 SBIR/STTR Transfer	-	0.277	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AK4 / *Multi-Role Small Guided Missile Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	-	6.104	7.692

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AK6 / *Advanced Rotorcraft Armaments Protection System Te*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AK6: *Advanced Rotorcraft Armaments Protection System Te*	-	0.000	5.313	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.313

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602624A Weapons and Munitions Technology
* Project H18 Weapons & Munitions Technologies

In FY21 this Project is realigned to:
PE 0603465A Future Vertical Lift Advanced Technology
* Project AK7 Adv Rotorcraft Armaments Protection Sys Adv Tech
* Project CA8 Adv Rotocraft Armaments Protection Sys

A. Mission Description and Budget Item Justification

This Project investigates holistic lethality technologies for Future Vertical Lift (FVL) offensive and defensive applications. Develops components for use in multi-role armament solutions for fire control, armament systems, munitions, and integration of threat agnostic countermeasures.

Work in this Project is fully coordinated with PE 0603465A (Future Vertical Lift Advanced Technology Development).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Advanced Rotorcraft Armament & Protection System (ARAPS)	-	5.072	-
Description: The ARAPS effort designs and develops FVL technologies for lightweight armament systems and multi-role munitions with enhanced lethality at extended ranges. The effort investigates and determines the feasibility of a holistic fire control system that integrates all aspects of offensive and defensive capabilities for advanced protection and enhanced survivability.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AK6 / *Advanced Rotorcraft Armaments Protection System Te*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will investigate integrated armament and advanced protection designs for FVL offensive and defensive applications; will design critical component technologies in order to develop advanced lethality and survivability capabilities in fire control, weapon systems, munitions and countermeasures; will investigate system architecture solutions for an integrated armament and advanced protection system. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding realigned in FY21 to PE 0603465A (Future Vertical Lift Advanced Technology / AK7 Adv Rotorcraft Armaments Protection Sys Adv Tech).			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.241	-
Accomplishments/Planned Programs Subtotals	-	5.313	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AK9 / *Adv Teaming for Tactical Aviation Operations Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AK9: *Adv Teaming for Tactical Aviation Operations Tech*	-	0.000	13.583	13.764	-	13.764	12.416	12.439	12.604	12.730	0.000	77.536

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602211A Aviation Technology:
* Project 47A AERON & ACFT Wpns Tech
* Project 47B Veh Prop & Struct Tech

A. Mission Description and Budget Item Justification

This Project investigates and develops subsystem and component level technologies that enable advanced teaming behaviors for mixed platform formations in combined arms operations. Primary component technologies to develop are in the areas of resilient autonomy algorithms, team-based communications and situational awareness management, decision aiding for weapons systems engagement, autonomous terrain and collision avoidance, and human autonomy interface design.

Work in this Project is fully coordinated with PE 0603465A (Future Vertical Lift Advanced Technology Development).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Advanced Teaming Concepts	-	9.468	9.811
Description: Investigates and develops subsystem and component level technologies that enable advanced manned and unmanned teaming behaviors for mixed air and ground platform formations in combined arms operations.			
FY 2020 Plans: Will develop and refine subsystem and component level technologies that enable autonomous manned and unmanned teaming and decision making, including autonomous terrain and collision avoidance, and advanced human autonomy interface designs; adapt and tailor simulation models for technology integration and evaluation.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AK9 / *Adv Teaming for Tactical Aviation Operations Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will develop mission systems teaming architectures and subsystem technologies focused on collaborative mission planning and execution, enhanced own-ship autonomy, shared team situational awareness using distributed sensor systems, and advanced effector employment; enhance simulation models for evaluation of multi-Unmanned Aircraft System (UAS) coordinated attack and decoy behaviors in Global Positioning System (GPS) denied conditions. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Micro/Small Scale Unmanned Aerial Systems ***Description:*** Enables micro/small Future Unmanned Aircraft System (FUAS) concepts for experimental prototypes to discover behaviors that can be scaled up to group 3 platforms to support advanced manned and unmanned air and ground teaming, and the maturation of basic research in the area of intelligent unmanned air systems. This includes controls that can adapt to damage or environmental conditions, models to perform aggressive maneuver in complex environments, reduction of noise signature, and adaptive structures. ***FY 2020 Plans:*** Will establish novel control schemes that will enable small unmanned aircraft systems to perform aggressive and energy aware maneuver through complex environments. Will incorporate higher fidelity methods into computationally efficient physics based modeling tools to enhance the design and maneuverability of novel FUAS concepts; this includes the establishment of an acoustics prediction module to enable the design of FUAS with reduced noise signature. Will perform applied research on novel platform concepts to enhance speed, endurance, payload capability, and adaptability. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This effort is realigned in FY21 to the Intelligent Unmanned Aerial System Teaming Technologies effort in this Project.	-	3.499	-
Title: Intelligent Unmanned Aerial System Teaming Technologies ***Description:*** Enables the establishment of component technologies to support resilient, multi-modal, survivable UAS teams that can plan and act on time-scales beyond human capability and have a robust shared understanding of contested and dynamic environments to support effective tactical engagement. Specific topics include 1) novel artificial-intelligence algorithms and methods for adaptive team composition and control, 2) increased team knowledge base and understanding of local and global world models, 3) hierarchical, composable, and adaptive learning methods for increased mission resilience, and 4) understanding interaction and scalability between, amongst, and across heterogeneous team members and the environment. ***FY 2021 Plans:*** Will investigate and develop novel control schemes that will enable homogeneous and heterogeneous groups of UAS to perform advanced teaming operations in complex environments; investigate and mature higher fidelity methods into computationally	-	-	3.953

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AK9 / *Adv Teaming for Tactical Aviation Operations Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
efficient physics-based modeling tools to enhance the understanding and effectiveness of tactical group behaviors against a capability-matched adversarial force utilizing game theoretic principles; perform research to progress methods for advanced teaming simulation environments to fully incorporate full vehicle flight dynamics models for a single platform and investigate methods for multi-agents. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This effort is realigned in FY21 from the Micro/Small Scale Unmanned Aerial Systems effort in this Project.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.616	-
Accomplishments/Planned Programs Subtotals	-	13.583	13.764

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AL2 / *High Performance Computing for Rotorcraft App Tech*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AL2: *High Performance Computing for Rotorcraft App Tech*	-	0.000	1.169	1.191	-	1.191	1.215	1.239	1.253	1.266	0.000	7.333

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602211A Aviation Technology
* Project 47A AERON & ACFT Wpns Tech.

A. Mission Description and Budget Item Justification

This Project investigates and validates aeromechanics modeling and simulation tools for Future Vertical Lift (FVL) platforms. Research efforts in this Project are also applicable to the family of FVL manned and unmanned platforms.

Work in this Project is fully coordinated with PE 0603465A (Future Vertical Lift Advanced Technology Development).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: High Performance Computing for Rotorcraft App Tech	-	1.116	1.191
Description: Investigate new high performance and parallel computing efforts in support of FVL platforms.			
FY 2020 Plans: Will investigate accurate, efficient, easy-to-use, and validated aeromechanics modeling and simulation tools based on computational fluid and structural dynamics on high-performance parallel computers.			
FY 2021 Plans: Will develop and demonstrate new automated high-fidelity computational tools for full-vehicle rotorcraft aeromechanics analysis and design. Will automate the setup and execution of these computational models to improve turnaround and to build in best practices for consistently accurate results.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AL2 / *High Performance Computing for Rotorcraft App Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Funding change reflects planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.053	-
Accomplishments/Planned Programs Subtotals	-	1.169	1.191

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AL4 / *High Speed and Efficient VTOL Vehicle Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AL4: *High Speed and Efficient VTOL Vehicle Technology*	-	0.000	1.500	1.499	-	1.499	1.499	1.529	1.546	1.546	0.000	9.119

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602211A Aviation Technology
* Project 47B Veh Prop & Struct Tech.

A. Mission Description and Budget Item Justification

This Project establishes component technologies in the area of materials, design, and dynamic models to enable next generation capability for Future Vertical Lift (FVL) platforms. Objectives of this Project are focused on improving both performance (i.e. range, payload, endurance) and reliability/maintainability metrics, where outcomes from these efforts are applicable to the Family of Future Vertical Lift manned and unmanned platforms.

Work in this Project is fully coordinated with PE 0603465A (Future Vertical Lift Advanced Technology Development).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: High Speed & Efficient Vertical Take-off and Landing	-	1.432	1.499
Description: This research effort establishes concepts in vertical take-off and landing in the area of propulsion to enable improved, efficient hover and high-speed cruise at longer range without added weight.			
FY 2020 Plans: Will conduct research on technologies that will reduce peak transient loads in multi-speed rotorcraft transmission, and perform material modeling of dissimilar materials for hybrid gear technology. Will mature dynamic finite-element/contact analysis modeling for mechanical failure analysis for variable speed transmission and high-temperature material and design component optimization for higher power density.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AL4 / *High Speed and Efficient VTOL Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will investigate lightweight materials and designs for transmission gears; establish, by experimental means, the bounds at oil-out conditions for lightweight gear designs. Will characterize and validate the dynamics of candidate hybrid gears. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects the planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.068	-
Accomplishments/Planned Programs Subtotals	-	1.500	1.499

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army												Date: February 2020
Appropriation/Budget Activity 2040 / 2					**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*				**Project (Number/Name)** AL5 / *Air Vehicle Structures and Dynamics Technology*			
COST ($ in Millions)	**Prior Years**	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**	**FY 2022**	**FY 2023**	**FY 2024**	**FY 2025**	**Cost To Complete**	**Total Cost**
AL5: *Air Vehicle Structures and Dynamics Technology*	-	0.000	2.766	2.824	-	2.824	2.887	2.945	2.978	3.008	0.000	17.408

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602211A Aviation Technology
* Project 47B Veh Prop & Struct Tech).

A. Mission Description and Budget Item Justification

This Project establishes validated modeling tools needed to develop aeroelastically stable rotor technologies to enable high speed flight and longer flight envelopes in Future Vertical Lift (FVL) platforms. Efforts in this Project are also applicable to the family of FVL manned and unmanned platforms.

Work in this Project is fully coordinated with PE 0603465A (Future Vertical Lift Advanced Technology Development).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2019**	**FY 2020**	**FY 2021**
Title: Air Vehicle Structures and Dynamics Technology	-	1.704	-
Description: Establish improved experimentally validated modeling tools and methodologies that can be used to understand the physics of aeroelastic stability and design in next generation rotorcraft platform configurations for FVL platforms. This involves the development of an experimental capability, the Tiltrotor Aeroelastic Stability Test-bed (TRAST), which would be used to generate novel experimental data. This data will be used to increase fundamental understanding of the whirl flutter instability, which currently limits the high speed performance of tiltrotor rotorcraft. This effort mitigates risk for the Joint Multi-Role Technology Demonstrator (JMR-TD) effort and informs FVL requirement definition and technology maturation. The experimentally validated models will also be used to investigate concepts to reduce the vibration and improve stability of future aircraft.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AL5 / *Air Vehicle Structures and Dynamics Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will evaluate the accuracy of current computational tools for the tilt-rotor configuration. Will complete the fabrication, acceptance tests, and initial wind tunnel test of TRAST, which will be used to generate novel wind tunnel experimental data to validate and refine the analytical modeling tools. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding for this effort realigned to Aeromechanics and Aeroelasticity of Future Air Vehicle Platforms effort within this Project.			
Title: Probabilistic and Damage Tolerance Methodologies ***Description:*** Advancement of probabilistic analytical algorithms and methods to enable air platform performance and availability. Probabilistic analytical methodologies resulting from this effort are expected to impact a broad range of air structure vehicle and dynamic technologies including enhanced damage tolerance. ***FY 2020 Plans:*** Will advance probabilistic analytics through exploitation of artificial intelligence and machine learning algorithms. Methods matured through this work will provide fundamental understanding for enhanced durability for next generation vertical lift manned and unmanned aircraft. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding for this effort realigned to Aeromechanics and Aeroelasticity of Future Air Vehicle Platforms effort within this Project.	-	0.937	-
Title: Aeromechanics and Aeroelasticity of Future Air Vehicle Platforms ***Description:*** Establish improved experimentally validated modeling tools and methodologies that can be used to understand the physics of aeroelastic stability and design in next generation rotorcraft platform configurations for FVL platforms. This involves the development of an experimental capability, (TRAST), which will be used to generate novel experimental data. This data will be used to increase fundamental understanding of the whirl flutter instability, which currently limits the high speed performance of tiltrotor rotorcraft. This effort will inform FVL requirement definition and technology maturation. This effort also establishes low noise rotor concepts and investigates the intersection of artificial intelligence and classical mechanics to enable novel mechanics and new approaches in structural dynamics for FVL applications to enable higher Operating Tempo (OPTEMPO) operations. ***FY 2021 Plans:*** Will conduct wind tunnel experiments of idealized tiltrotor configurations to understand the effects of rotor, wing, control parameters, and dynamic and aerodynamic coupling on aircraft stability to enable faster, more efficient, and sustainable tiltrotor aircraft. Will increase understanding of aerodynamic and acoustic interactions through simulation and experiments; validate modeling capabilities for multi-rotor and compound vertical lift concepts to enable quieter operations. Will advance knowledge of	-	-	2.824

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AL5 / *Air Vehicle Structures and Dynamics Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
underlying mechanics through exploration of materials for vibrational damping, actuation, and sensing through experiments and artificial intelligence/machine learning to enable the development of massively reconfigurable air vehicle configurations. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21, this effort is realigned from Air Vehicle Structures and Dynamics Technology, and Probabilistic and Damage Tolerance Methodologies efforts in this Project.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.125	-
Accomplishments/Planned Programs Subtotals	-	2.766	2.824

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AL8 / *Holistic Situational Awareness and Dec Making Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AL8: *Holistic Situational Awareness and Dec Making Tech*	-	0.000	1.745	1.783	-	1.783	1.819	1.855	1.877	1.896	0.000	10.975

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602120A Sensors and Electronic Survivability
* Project H16 S3I Technology
PE 0602705A Electronics and Electronic Devices
* Project H94 Elec & Electronic Dev

A. Mission Description and Budget Item Justification

This Project focuses on modeling and simulation of pilotage and decision aiding system technology that allows for care free operations in complex and hostile environments.

Work in this Project is fully coordinated with PE 0603465A (Future Vertical Lift Advanced Technology Development).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Radar Sensing and Phenomenology	-	1.665	-
Description: This effort develops the technical underpinnings of radar and other active and passive radio frequency (RF) sensing modalities for several key Army requirements. Focus in on cost effective radar concepts to enhance the situational awareness and navigation capabilities of US Army rotorcraft, allowing safe operation in Degraded Visual Environment (DVE). This research uses a combination of advanced computational electromagnetic models and algorithms, radar measurements, active and passive RF sensing technologies, and advanced signal processing.			
FY 2020 Plans: Will investigate novel forward looking synthetic aperture radar (FLSAR) concept for DVE using high fidelity electromagnetic radar signature models and verify with proof-of-concept laboratory measurements. Will explore techniques and algorithms to extend			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AL8 / *Holistic Situational Awareness and Dec Making Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
the capability of rotorcraft collision avoidance radars to a hostile fire detection mode of operation and will investigate alternative architectures and modes of operation for FLSAR for imaging landing zones and targeting in DVE. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 effort realigned within Project scope to Wideband RF Sensors and Situational Awareness Radar for DVE mitigation efforts within this Project.			
Title: Wideband RF Sensors ***Description:*** This effort develops the technical underpinnings of radar and other active and passive RF sensing modalities for several key Army requirements, with a focus on cost effective radar concepts to enhance the situational awareness and navigation capabilities of US Army rotorcraft to operate safely in DVE. This research uses a combination of advanced computational electromagnetic models and algorithms, radar measurements, active and passive RF sensing technologies, and advanced signal processing. ***FY 2021 Plans:*** Will investigate and explore FLSAR design options and develop instrumentation to collect outdoor data. Will implement fast 3-D SAR imaging algorithm for signal processor that leverages the architecture and capability of advanced Graphics Processor Units (GPUs). ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort realigned from Radar Sensing and Phenomenology effort within this Project.	-	-	0.892
Title: Situational Awareness Radar for DVE mitigation ***Description:*** This effort investigates technologies and algorithms for compact radars that will provide a hazard warning capability to airborne platforms in all environmental conditions, including those with zero visibility. This hazard warning capability will detect collision threats and specific projectile hazards around the entire aircraft using a suite of small form-factor radars. Algorithms are created to interpret the data produced by these radars and distinguish threats from benign clutter. Innovative radar architectures and device technologies are investigated and demonstrated to enhance and extend performance. ***FY 2021 Plans:*** Will investigate waveforms to minimize interference between the radars on different platforms and reduce their susceptibility to detection and electronic attack. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21 this effort realigned from Radar Sensing and Phenomenology effort within this Project.	-	-	0.891
Title: FY 2020 SBIR/STTR Transfer	-	0.080	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AL8 / *Holistic Situational Awareness and Dec Making Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	-	1.745	1.783

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AM2 / *Aircraft and Aircrew Protection Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AM2: *Aircraft and Aircrew Protection Technology*	-	0.000	1.522	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.522

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602211A Aviation Technology
* Project 47A Aeron & ACFT Wpns Tech

In FY21 this Project is realigned to:
PE 0602148A Future Verticle Lift Technology
* Project AJ4 Digital Vehicle Management and Control Technology

A. Mission Description and Budget Item Justification

This Project investigates and develops leap-ahead structures technologies, concepts, and capabilities that enable break-through improvements in weight efficiency, performance, and extreme-environment operational durability, as well as enhanced platform design, qualification, and fleet structural integrity management for application to Future Vertical Lift (FVL) platforms. Technologies also have applicability to Future Unmanned Aircraft Systems (FUAS).

Work in this Project is fully coordinated with PE 0603465A (Future Vertical Lift Advanced Technology Development).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Aircraft & Aircrew Protection	-	1.453	-
Description: Enables survivable, sustainable rotorcraft configurations by conceiving of and evaluating critical aviation technologies using design and analysis methods with greater modeling fidelity with an ultimate goal of reducing the timelines associated with overall design of FVL and FUAS platforms. Introduces high fidelity methodology for improved performance and design predictions earlier in the development and acquisition process. Use physics of failure modeling and coupled discipline analysis to drastically improve component and system reliability.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AM2 / *Aircraft and Aircrew Protection Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will develop more accurate analytical prediction of rotorcraft internal structural loads resulting from external air loads, and light-weight biology-inspired structural concepts enabling on-the-fly configuration adaptation for near-optimal performance and protection across various flight conditions. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This Project is realigned in FY21 to PE 602148A (Future Vertical Lift Technology) / AJ4 (Digital Vehicle Management and Control Technology).			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.069	-
Accomplishments/Planned Programs Subtotals	-	1.522	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AM4 / *Opt Energy Stg & Therm Mgmt for FVL Survivability*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AM4: *Opt Energy Stg & Therm Mgmt for FVL Survivability*	-	0.000	4.912	8.674	-	8.674	7.356	7.533	7.634	7.635	0.000	43.744

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602705A Electronics and Electronic Devices
* Project H11 Tactical and Component Power Technology.

A. Mission Description and Budget Item Justification

This Project investigates emerging power generation, energy storage, and thermal management technologies needed for future Command, Control, Communications, Computers, Cyber, Intelligence, Surveillance and Reconnaissance (C5ISR) and survivability equipment that could be incorporated onto Future Vertical Lift (FVL) and other Army platforms. Provides power capability for advanced electric aeromechanical effectors, advanced mission systems algorithms for route planning and teaming and advanced electronic warfare devices.

Work in this Project is fully coordinated with PE 0603465A (Future Vertical Lift Advanced Technology Development).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Optimized Energy for C5ISR Platforms	-	4.912	4.948
Description: This effort investigates power and thermal management associated with high power C5ISR capabilities on ground and air platforms enabling enhanced mobility and mission flexibility. This effort funds research to improve FVL aircraft and other Army platforms power efficiency through the use of on-demand hybrid power architectures, while also researching ways to eliminate platform thermal constraints. This effort will also investigate very high density power sources and energy storage for high rate pulsed power, power management, and thermal management for dynamic high rate pulsed power.			
FY 2020 Plans: Will investigate power requirements for emerging C5ISR capabilities to include directed energy, lasers, high power sensors, and electromagnetic weapons. Will develop models based on size, weight, and power requirements and aircraft platform constraints which include architectures and intelligent control variants to manage these loads. Will analyze the high resolution characterization			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AM4 / *Opt Energy Stg & Therm Mgmt for FVL Survivability*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
of cyclical, step and high power load profiles likely to result from use of lasers or other high power, short duration burst technology to inform the modularization of the storage technology needed to support the loads. Will examine thermal implications of waste heat generated from inefficiencies in power conversation and its impact on the aircraft. Will conduct experiments on hybrid energy storage technologies to support cyclical loads such as hybrid batteries or ultra-capacitor technology. Will define models for the use of intelligent control strategies for platform integrated power systems. ***FY 2021 Plans:*** Will investigate power requirements for emerging C5ISR. Will explore use of models based on size, weight, and power requirements and aircraft platform constraints, which include architectures and intelligent control variants for management of these loads. Will conduct experiments on the modularization of the storage technology needed to support high power, short duration burst loads. Will investigate thermal implications of waste heat generated from inefficiencies in power conversion and its impact on the aircraft. Will conduct experiments on hybrid energy storage technologies to support cyclical loads such as hybrid batteries or ultra-capacitor technology. Will validate models of intelligent controls for platform-integrated power systems to conduct experiments on control strategies. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Power & Thermal Management Components ***Description:*** This effort develops power and thermal management component technologies to meet the power and thermal demands of Future Vertical Lift aircraft while minimizing system size and weight. Technology will be validated through component level test. ***FY 2021 Plans:*** Will develop and perform component level validation testing on advanced power generation technologies such as lightweight, efficient turbo-generators and advanced thermal management technologies specifically designed for application to FVL aircraft. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This effort has been realigned in FY21 from PE 0602148A (Future Vertical Lift Technology) / AI7 (Alternative Concept Engine Technology).	-	-	3.726
Accomplishments/Planned Programs Subtotals	-	4.912	8.674

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** AM4 / *Opt Energy Stg & Therm Mgmt for FVL Survivability*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** BP7 / *Future Vertical Lift Air Platform Tech (CA)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BP7: *Future Vertical Lift Air Platform Tech (CA)*	-	0.000	14.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	14.000

Note

Congressional Interest Item funding provided for Future Vertical Lift Air Platform Technology.

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Future Vertical Lift Platform Technology.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Flight Control Technology Safety and Survivability ***FY 2020 Plans:*** Flight Control Technology Safety and Survivability	-	3.000
Congressional Add: Rotary Wing Adaptive Flight Control Technology ***FY 2020 Plans:*** Rotary Wing Adaptive Flight Control Technology	-	6.000
Congressional Add: Technology Transfer and Innovation ***FY 2020 Plans:*** Technology Transfer and Innovation	-	5.000
Congressional Adds Subtotals	-	14.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** BZ7 / *Future Vertical Lift Medical Technologies*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BZ7: *Future Vertical Lift Medical Technologies*	-	0.000	0.000	8.211	-	8.211	8.195	8.292	8.492	8.493	0.000	41.683

Note

In Fiscal Year 2021 (FY21) this Project was realigned from:
Program Element (PE) 0602787A Medical Technology
* MK4 Warfigher Health Applied Rsch Technology

A. Mission Description and Budget Item Justification

This Project involves research to prevent injury and performance degradation in Aviators, Unmanned Arial System (UAS) Operators and other Warfighters in training and operations; refines risk assessment and performance models based on operational stressors, e.g., sleep deprivation, work load, fatigue; and delivers biomedical-based spinal injury criteria and assessment methodologies. This research provides medical information important to the design and operational use of future vertical lift aircraft, and when appropriate, ground vehicles.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Medical Standards to Support Future Vertical Lift	-	-	8.211
Description: This effort entails development of medical input for equipment and personnel standards for Future Vertical Lift (FVL) aircraft and personnel. Efforts will address visual display guidelines, risk and performance standards for FVL operators and injury criteria and assessment methods for seated occupants.			
FY 2021 Plans: Will develop advanced visual display guidelines to assist aviators in maintaining situational awareness during extreme degraded visual environment (DVE) conditions. Will develop aviator composite risk assessment and performance model based on DVE and other operational stressors. Will deliver to the Aviation and Missile Center (AvMC) for FVL, and when appropriate, to the Ground Vehicle Systems Center (GVSC) for the Next Generation Combat Vehicle (NGCV), provisional biomedical-based spinal injury criteria and assessment methodologies for two types of vertebral body fractures that seated occupants experience during vertical exposures.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** BZ7 / *Future Vertical Lift Medical Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
This Project is realigned in FY21 from PE 0602787A (Medical Technology) / MK4 (Warfigher Health Applied Rsch Technology).			
Accomplishments/Planned Programs Subtotals	-	-	8.211

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** CC3 / *FVL Radar Technologies*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
CC3: *FVL Radar Technologies*	-	0.000	0.000	0.724	-	0.724	0.450	0.000	0.000	0.000	0.000	1.174

Note

In Fiscal Year 2021 (FY21) this Project was realigned from:
Program Element (PE) 0602270A / Electronic Warfare Technology
*906 Tactical Electronic Warfare Applied Research.

A. Mission Description and Budget Item Justification

This Project develops underlying technologies applicable to next generation radar apertures used for detection, tracking and precision targeting, navigation and fire control for multiple modalities.

Work in this Project is fully coordinated with PE 0603465A (Future Vertical Lift Advanced Technology Development).

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

Work in this Project is performed by the Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Battlefield Surveillance & Targeting Radar Technology ***Description:*** Advanced Reconnaissance, Surveillance and Target Acquisition Waveform Designs for advanced multi-beam Ground Moving Target Indicator (GMTI) and Synthetic Aperture Radar (SAR) systems. ***FY 2021 Plans:*** Will investigate modeling and simulation of subsystem and component level designs for advanced GMTI and SAR systems. Will investigate standards and interface requirements necessary to facilitate integration of scalable Radio Frequency (RF) components at the sub aperture level; conduct experiments to determine optimal techniques for waveform optimization to mitigate spectrum challenges. Will investigate multi-function RF modes and waveforms external to traditional SAR and GMTI radar collection. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increase due to realignment from PE 0602270A / Electronic Warfare Technology (multiple projects)	-	-	0.724
Accomplishments/Planned Programs Subtotals	-	-	0.724

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602148A / *Future Verticle Lift Technology*	**Project (Number/Name)** CC3 / *FVL Radar Technologies*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	0.000	95.771	56.298	-	56.298	51.609	41.272	41.729	42.006	0.000	328.685
AC9: *High Energy Laser Tactical Vehicle Demonstrator Te*	-	0.000	11.114	9.349	-	9.349	0.000	0.000	0.000	0.000	0.000	20.463
AD2: *High Energy Laser (HEL) Enabling and Support Techn*	-	0.000	7.963	10.113	-	10.113	8.278	8.444	8.538	8.539	0.000	51.875
AD3: *Maneuver Air Defense Technology*	-	0.000	4.200	13.227	-	13.227	10.264	2.304	3.564	5.825	0.000	39.384
AD5: *Next Generation Fires Radar Technology*	-	0.000	9.256	5.336	-	5.336	5.421	3.961	4.005	4.005	0.000	31.984
AD7: *Missile Fire Control Sensors Technology*	-	0.000	1.608	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.608
AD9: *Close Combat High Energy Laser Technology*	-	0.000	7.357	8.696	-	8.696	20.354	21.009	21.244	21.457	0.000	100.117
AE2: *Unconventional Countermeasures-Survivability Tech*	-	0.000	5.756	6.588	-	6.588	3.976	2.160	2.180	2.180	0.000	22.840
AE4: *Collaborative ISR Sensors Technology*	-	0.000	3.517	2.989	-	2.989	3.316	3.394	2.198	0.000	0.000	15.414
BN6: *Advanced Weapons Components (CA)*	-	0.000	45.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	45.000

Note

In Fiscal Year (FY) 2020, this Program Element (PE) was realigned with continuity of effort from the following PEs:
* 0602120A Sensors and Electronic Survivability
* 0602303A Missile Technology
* 0602307A Advanced Weapons Technology
* 0602705A Electronics and Electronic Devices
* 0602784A Military Engineering Technology

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	**Date:** February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*

A. Mission Description and Budget Item Justification

Work in this PE investigates and develops Air and Missile Defense (AMD) technologies to enable defense of ground forces and selected geopolitical assets from aerial attack, missile attack, and surveillance. Major focus areas for AMD Science and Technology include: Missiles, Directed Energy, Gun-Based Air Defense Technologies, and Battlefield Sensors and Supporting AMD Technologies. Missiles Applied Research investigates and develops a broad range of Missile technologies to enhance Army integrated AMD capabilities at extended range. Directed Energy Applied Research investigates and develops critical High Energy Laser (HEL) technologies to explore performance against Air Defense threats and for other Directed Energy applications across Army Modernization Priorities. Gun-Based Air Defense Technologies Applied Research investigates and develops Combined Arms for Air Defense (CAFAD) technologies and components in a laboratory environment. Sensors and Supporting AMD Technologies Applied Research investigates and develops Battlefield Sensor and radar technologies required for detection, acquisition and tracking of air defense targets as well as supporting technologies that enhance AMD.

Work in this PE complements PE 0603466A (Air and Missile Defense 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 (AFC), the United States Army Space and Missile Defense Command/Army Strategic Forces Command (SMDC/ARSTRAT), and the United States Army Rapid Capabilities and Critical Technologies Office (RCCTO).

B. Program Change Summary ($ in Millions)	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**
Previous President's Budget	0.000	50.771	58.558	-	58.558
Current President's Budget	0.000	95.771	56.298	-	56.298
Total Adjustments	0.000	45.000	-2.260	-	-2.260
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	45.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	-2.260	-	-2.260

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2019**	**FY 2020**
Project: BN6: *Advanced Weapons Components (CA)*		
Congressional Add: *Sustainable Energy Materials and Manufacturing*	-	12.000
Congressional Add: *High-Energy Laser Hardware in the Loop*	-	20.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2019	FY 2020
Congressional Add: *COE in High-Energy Laser and Optical Technology*	-	3.000
Congressional Add: *Cybersecurity and Supply Chain Risk Management*	-	10.000
Congressional Add Subtotals for Project: BN6	-	45.000
Congressional Add Totals for all Projects	-	45.000

Change Summary Explanation

FY20 increase related to FY20 Congressional Adds.

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*	**Project (Number/Name)** AC9 / *High Energy Laser Tactical Vehicle Demonstrator Te*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AC9: *High Energy Laser Tactical Vehicle Demonstrator Te*	-	0.000	11.114	9.349	-	9.349	0.000	0.000	0.000	0.000	0.000	20.463

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) PE 0602307A Advanced Weapons Technology
* Project 042 High Energy Laser Technology

A. Mission Description and Budget Item Justification

This Project investigates component technologies for mobile high energy laser (HEL) weapon systems in solid state lasers (SSL) for use in protecting fixed and semi-fixed sites from Rocket, Artillery, and Mortars (RAM), Unmanned Aerial Systems (UAS) and advanced Air Defense threats. The Project researches advanced technologies for HEL weapon systems to enable more efficient laser systems with significantly greater power output for future HEL weapons to augment current kinetic Air Defense Artillery (ADA) systems and address additional missions with a low cost-per-kill exchange ratio. This includes technologies to support development of alternate laser sources, precision optical pointing and tracking components and adaptive optics to overcome laser degradation due to atmospheric effects to gain great lethality permitting expansion of threats set. Additionally development of compact and lighter weight energy generation and storage devices, and more efficient thermal management systems to remove excess heat will permit integrating laser weapons on additional combat platforms.

Work in this Project complements PE 0603466A (Air and Missile Defense Advanced Technology) / Project AD1 (High Energy Laser Tactical Vehicle Demonstrator 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 and supports the Army's future capability opportunities for leap-ahead technology for directed energy.

Work is performed by the United States (US) Army Rapid Capabilities and Critical Technologies Office (RCCTO).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: High Energy Laser Tactical Vehicle Demonstrator Technology	-	11.114	9.349
Description: This effort develops technologies for robust beam control and SSL subsystems in the HEL Tactical Vehicle Demonstrator (TVD). Technologies developed under this effort will enable lighter, more agile beam control systems for tactical Army platform development and SSL technologies that enhance effectiveness against emerging air defense threats and increase efficiencies, enabling reductions in size, weight and power (SWaP) and improving the ability to integrate SSL systems into multiple Army weapon platforms.			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*	**Project (Number/Name)** AC9 / *High Energy Laser Tactical Vehicle Demonstrator Te*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2020 Plans: Will complete development of the gimbal, telescope and main optics bench for the HEL TVD beam control system; Will utilize knowledge/design from FY19 Adaptive Optics component demonstration and incorporate state-of-the-art optical focal planes to extend effectiveness of laser system in challenging environments to make the HEL TVD beam control system more robust; Will prepare beam control subsystem for integration with other subsystems in the system integration laboratory; Will complete development of the 100 kW laser subsystem for the HEL TVD; Will prepare laser system for integration with beam control, power and thermal subsystems in the system integration laboratory. ***FY 2021 Plans:*** Will conduct experimentation with prototype HEL TVD surrogate beam control system to characterize the performance of the base design: assess Adaptive Optics (AO) component demonstration and incorporate state-of-the-art optical focal planes to extend effectiveness of laser system in challenging environments to inform the HEL TVD beam control system design; Will prepare beam control subsystem for integration with other subsystems in the system integration laboratory; Will continue investigation, modeling & simulation, assessment, and development of laser subsystems (e.g. laser sources, power and thermal subsystems) necessary for defeat of emerging and advanced air defense threats for the HEL TVD. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funds moved within this PE to Project AD2 (High Energy Laser Enabling and Support Technology) in order to further develop the Mobile Beam Control Systems Integration Laboratory (MBC SIL).			
Accomplishments/Planned Programs Subtotals	-	11.114	9.349

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*	**Project (Number/Name)** AD2 / *High Energy Laser (HEL) Enabling and Support Techn*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AD2: *High Energy Laser (HEL) Enabling and Support Techn*	-	0.000	7.963	10.113	-	10.113	8.278	8.444	8.538	8.539	0.000	51.875

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602307A Advanced Weapons Technology
* Project Code 042 High Energy Laser Technology
PE 0602705A Electronics and Electronic Devices
* Project EM8 High Power And Energy Component Technology

A. Mission Description and Budget Item Justification

This Project conducts static and dynamic High Energy Laser (HEL) vulnerability and lethality analyses and investigates advanced component technologies to enhance performance of future HEL weapons systems against advanced threats. In addition, this Project includes laboratory efforts for HEL applied research as well as concepts analysis for Army core competencies in directed energy. This Project also investigates advanced laser technologies based on unconventional solid-state laser concepts, architectures, and thermal/power management schemes for the development of low size, weight, and power (SWaP) Army directed energy (DE) weapons and tactical laser developers.

Work in this effort compliments other Army Directed Energy efforts conducted under PE 0602150A (Air and Missile Defense Technology) and PE 0603466A (Air and Missile Defense Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas, the Army Modernization Strategy, and supports the Army's future capability opportunities for leap-ahead technology for directed energy.

Work is performed by the United States Army Space and Missile Defense Command - Technical Center (USASMDC-TC) and the United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: High Energy Laser Enabling and Support Technology	-	6.774	8.032
Description: This effort provides the underlying data for future high energy laser weapons to effectively engage an array of threats. The data includes prioritized aim points on each threat as well as time to defeat the threats for each aim point. This activity includes the full spectrum of target lethality investigations and engagement of flying targets in relevant scenarios. This activity is primarily executed at the Solid State Laser Testbed (SSLT) facility at White Sands Missile Range, New Mexico. This effort also focuses on developing core Army expertise through laser and beam control technology assessments, applied research and			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*	**Project (Number/Name)** AD2 / *High Energy Laser (HEL) Enabling and Support Techn*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
other technical core competencies.This effort focuses on developing in-house expertise in Adaptive Optics (AO), Beam Control, laser diodes, target illuminators lasers and beacon illuminator lasers, laser diagnostics and new tracking algorithms. These technologies can be integrated into the High Energy Laser Tactical Vehicle Demonstrator (HEL TVD), and the Multi Mission High Energy Laser (MMHEL), or future laser systems to locate, identify and engage critical targets. Results of this research may reduce the SWaP requirements, and the efficacy of laser weapons systems on Army platforms in the future. ***FY 2020 Plans:*** Will complete an assessment of rocket, artillery and mortar (RAM) fuzes vulnerability to laser weapons; Will complete vulnerability modules and lethality database inputs for Groups 1, 2, and 3 Unmanned Aerial Systems. Will continue development of lethality data base input for RAM threats supporting HEL TVD and MMHEL. Will begin data collection on vulnerability of manned fixed- and rotary-wing aircraft components. ***FY 2021 Plans:*** Will conduct experiments to inform fixed wing threat assessment and develop defeat methodologies; will begin preliminary assessment of high energy laser effectiveness against Anti-Tank Guided Missile threats; will continue development of lethality database for RAM threats supporting the Maneuver - Short Range Air Defense (M-SHORAD) mission. Continue to evaluate and conduct experiments with advanced AO algorithms for deep turbulence atmospheric conditions. Integrate the Enhanced Tracking Sensor for Acquisition Tracking onto the MBC SIL for dynamic experiments. Complete Candidate Sensor Technology analysis for HEL Fine Tracking and Aimpoint designation in a pulsed illuminator and gated sensor configuration. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Resources realigned in FY21 to increase focus on laser defeat techniques against Anti-Tank Guided Missile threats.			
Title: High Energy Laser Enabling Technologies for Tactical Directed Energy Weapons ***Description:*** Research novel solid-state laser concepts, architectures, and components in support of the Army?s HEL weapons strategy; exploit breakthroughs in laser technology, develop and employ innovative laser gain material, and utilize photonics to meet the stringent weight/volume requirements for Army platforms, especially to enhance and improve the generation, transmission, and reception of lasers. ***FY 2020 Plans:*** Will investigate advanced ?crystalline core/crystalline cladding? designs (a.k.a. CCCC = C4) to enable single transverse mode HEL with single fiber laser power scaling potential 10X over the current state of the art; will explore directly diode-cladding pumped	-	1.189	2.081

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*	**Project (Number/Name)** AD2 / *High Energy Laser (HEL) Enabling and Support Techn*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Raman fiber laser architectures enabling power scaling out of a single fiber laser for 10X improvement over the current state of the art; and will conduct feasibility experiments of optical-phased arrays to beam steer and condition the phase of laser emissions. ***FY 2021 Plans:*** Will investigate the potential of true-continuous wave fiber laser power scaling with crystalline core/crystalline cladding fibers; will investigate power scaling potential of directly diode-cladding pumped Raman fiber laser. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Resources realigned in FY21 to increase and accelerate focus on advanced fiber laser technologies.			
Accomplishments/Planned Programs Subtotals	-	7.963	10.113

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*	**Project (Number/Name)** AD3 / *Maneuver Air Defense Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AD3: *Maneuver Air Defense Technology*	-	0.000	4.200	13.227	-	13.227	10.264	2.304	3.564	5.825	0.000	39.384

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602303A Missile Technology
* Project 214 Missile Technology

A. Mission Description and Budget Item Justification

This Project directly supports Army Modernization Priority Air and Missile Defense capabilities by investigating and developing critical missile technologies and components necessary for an affordable short range air defense interceptor capability to defeat Cruise Missile (CM), Rotary Wing (RW), Tactical / Lethal Unmanned Aerial System (UAS), and Fixed Wing (FW) threats. This effort also designs and develops technologies to provide reduced size weight and power and cost for Maneuver Short Range Air Defense (MSHORAD), Short Range Air Defense (SHORAD), and Lower Tier essential to maintain overmatch against mid-/far-term threats.

Work in this Project complements PE 0603466A (Air and Missile Defense Advanced Technology) / Project AD4 (Maneuver Air Defense Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Maneuver Air Defense Technology	-	4.200	10.994
Description: Investigates and develops critical missile technologies and components necessary for an affordable short range air defense interceptor capability to defeat RW, Tactical / Lethal UAS, and FW threats.			
FY 2020 Plans: Will conduct MSHORAD trade studies to develop the system concept and derive system level requirements for interceptor sub-systems; will determine the optimum launcher configuration to maximize magazine depth on a maneuver platform; Investigate and develop critical missile technologies and components that support the development of an interceptor capability for the MSHORAD requirement; and evaluate application of common guidance electronic unit and low cost RF seeker. Characterization of threat signatures and develop Hardware In the Loop (HWIL) techniques to emulate them.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*	**Project (Number/Name)** AD3 / *Maneuver Air Defense Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will continue development of critical missile technologies for detection and tracking of hovering RW targets; will develop and investigate an active radar seeker with integrated warhead fuzing capabilities through HWIL techniques for emulating hovering RW targets and other large MSHORAD targets in a laboratory environment. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Increase in funding required to develop, fabricate, integrate and validate technologies in laboratory and HWIL environments.			
Title: Future Air Defense Missile Enabling Technology ***Description:*** Designs and develops reduced cost advanced Air Defense missile critical components essential to maintain overmatch against Mid/Far term Maneuver-Short Range Air Defense threats. ***FY 2021 Plans:*** Will perform component level trade studies and explore and develop new technologies to address emerging Maneuver-Short Range Air Defense threats and reduce space, weight, power and cost for future Air Defense missile guidance/maneuverability/ control, aerostructures, and propulsion technologies. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Efforts realigned from Project AD7 (Missile Fire Control Sensors Technology) in this PE and focused on future air defense missile component technologies that are essential to engage and defeat increasingly stressing threats at extended ranges.	-	-	2.233
Accomplishments/Planned Programs Subtotals	-	4.200	13.227

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*	**Project (Number/Name)** AD5 / *Next Generation Fires Radar Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AD5: *Next Generation Fires Radar Technology*	-	0.000	9.256	5.336	-	5.336	5.421	3.961	4.005	4.005	0.000	31.984

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602303A Missile Technology:
* Project 214 Missile Technology
PE 0602120A Sensors and Electronic Survivability
* Project H16 S3I Technology
PE 0602705A Electronics and Electronic Devices
* Project H94 Elect & Electronic Devices

A. Mission Description and Budget Item Justification

This Project directly supports Army Modernization Priority Air and Missile Defense capabilities by investigating and developing advanced radar technologies for insertion into Multi-Mission Army Radar systems. This Project addresses challenges facing simultaneously achieving high linearity and efficiency at high frequencies, accuracy in the underlying high frequency device and circuit models, integration of new material into Silicon complementary metal-oxide-semiconductor (CMOS) processing flows, and electronics reliability that appear as new semiconductor materials are developed and feature sizes shrink.

Work in this Project complements PE 0603466A (Air and Missile Defense Advanced Technology) / Project AD6 (Next Generation Fires Radar Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Advanced Fire Control Radar Technologies	-	4.000	-
Description: This effort develops advanced radar technologies for insertion into Multi- Mission Army Radar systems			
FY 2020 Plans: Will further develop Digital Array Radar technologies; will complete the design and development the full array hardware and begin testing with Radio Frequency (RF) characterization, digital beam forming evaluations, and algorithm and scenario development;			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*	**Project (Number/Name)** AD5 / *Next Generation Fires Radar Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
begin implementation of Future Fires Radar open systems architecture back-end processing; will refine and increase capabilities for target identification and discrimination algorithms utilizing threat flight dynamics and multiple sensors. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding decrease due to realignment to support higher priority Army Science and Technology (S&T) efforts.			
Title: Multi-Mode Air Defense Radar ***Description:*** This research supports the technical challenges associated with air defense radar technology. In particular, this effort will analyze current and emerging RF spoofing, RF jamming, and RF signature management technologies to determine their impact on the performance of air defense radars. Electromagnetic modeling, RF measurements, and experiments will be used to identify mitigation techniques for spoofing and jamming, and to identify useful signature management technologies. This will also include research in electronic devices, sub-assembly design, and laboratory experiments to advance the state-of-the-art of air defense radars operating in contested electronic environments. ***FY 2020 Plans:*** Will research techniques and algorithms for the calibration of digital phased array radars and create electromagnetic models of performance; and will assure algorithms are compatible with an existing Army open software architecture in support of air defense radar mission. ***FY 2021 Plans:*** Will develop algorithms for digital radar on laboratory hardware and assess compatibility with Army digital radar designs and testbeds; will develop and model techniques and algorithms for survivable, cognitive, and distributed radar and quantify implications for radar device technology. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding update to reflect project lifecycle status.	-	1.510	1.522
Title: Antennas and RF Device Components for Advanced Electronic Systems ***Description:*** This effort designs, characterizes, and validates high performance antennas, microwave components, and software for multifunction radar, RF sensing, and communication and position/timing systems. Research areas include scanning techniques, broadbanding, beamforming, polarization, platform integration, and affordability. For microwave components, research areas include software defined radios, analog-to-digital conversion rates, bandwidth resolution, bit accuracy, circuit design and affordability. ***FY 2020 Plans:***	-	3.746	3.814

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*	**Project (Number/Name)** AD5 / *Next Generation Fires Radar Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will demonstrate counter-RF jamming algorithms utilizing digital RF hardware; will characterize meta-ferrite antennas for enhanced RF situational awareness; will design and develop antennas, front end technologies, and enabling devices and integrated circuits operating at millimeter wave frequencies (at/near 5G frequencies) to support directional communications; will mature RF microelectromechanical systems (MEMS) components to enable frequency agile operation of tactical communication and next generation fires radar using reconfigurable impedance matching between disparate RF components and antenna tuning; and will explore and develop machine learning techniques and algorithms for RF modulation recognition and target classification. ***FY 2021 Plans:*** Will validate additively manufactured RF antenna arrays for scalability; will validate efficient, multi-band, and survivable high power components and research ultra-wide bandgap semiconductor device technology for meeting power efficiency challenges. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding update to reflect project lifecycle status.			
Accomplishments/Planned Programs Subtotals	-	9.256	5.336

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*	**Project (Number/Name)** AD7 / *Missile Fire Control Sensors Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AD7: *Missile Fire Control Sensors Technology*	-	0.000	1.608	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.608

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0602303 Missile Technology:
* Project 214 Missile Technology

In FY21 this Project is realigned to:
PE 06702150A Air and Missile Defense Technology:
* Project AD3 Maneuver Air Defense Technology

A. Mission Description and Budget Item Justification

This Project directly supports Army Modernization Priority Air and Missile Defense capabilities by designing and developing technologies for advancements in next generation fire control sensor technology and target signature modeling.

Work in this Project complements PE 0603466A (Air and Missile Defense Advanced Technology) / Project AD6 (Next Generation Fires Radar Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Missile Fire Control Sensors Technology	-	1.608	-
Description: Design and develop technologies for advancements in next generation fire control sensor technology and target signature modeling. ***FY 2020 Plans:*** Will continue to develop modulated waveforms for next generation radars and seekers in order to improve target resolution and discrimination for challenging air defense scenarios; will develop engagement planning algorithms to include target identification			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*	**Project (Number/Name)** AD7 / *Missile Fire Control Sensors Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
and discrimination based on emerging threat information, advanced capabilities of emerging sensors, and future interceptor capabilities. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** FY21 efforts realigned to PE 0602150A (Air and Missile Defense Technology)/Project AD3 (Maneuver Air Defense Technology)			
Accomplishments/Planned Programs Subtotals	-	1.608	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*	**Project (Number/Name)** AD9 / *Close Combat High Energy Laser Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AD9: *Close Combat High Energy Laser Technology*	-	0.000	7.357	8.696	-	8.696	20.354	21.009	21.244	21.457	0.000	100.117

Note

In Fiscal Year 2020 (FY20) this Project was realigned from:
Program Element (PE) 0062307A Advanced Weapons Technology
* Project 042 High Energy Laser Technology

A. Mission Description and Budget Item Justification

This Project investigates and develops technologies for compact, highly efficient lasers, and compact beam control for close-combat platforms. This project investigates and develops advanced technologies for High Energy Laser (HEL) weapon systems to enable more efficient laser systems with greater power output, which in-turn enables laser weapons on smaller vehicles for additional missions. This includes technologies to support development of alternate laser sources, precision optical pointing and tracking components, adaptive optics to overcome laser degradation due to atmospheric effects, more compact and lighter weight energy generation and storage devices, and more efficient thermal management systems to remove excess heat.

Work in this Project complements PE 0603466A (Air and Missile Defense Advanced Technology) / Project AE1 (Close Combat High Energy Laser 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, and supports the Army's future capability opportunities for leap-ahead technology for directed energy.

Work is performed by the United States (US) Army Rapid Capabilities and Critical Technologies Office (RCCTO).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Close Combat High Energy Laser Technology	-	7.117	8.696
Description: This effort develops laser and beam control technologies with extremely low size, weight, and power (SWaP) requirements enabling high energy lasers in small, agile close combat platforms. Extremely low SWaP laser systems will expand the laser weapons mission set. Reduction in SWaP also provides for higher power systems on the large tactical vehicles that enable countering the current threat set at longer ranges as well as laser-hardened threats.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*	**Project (Number/Name)** AD9 / *Close Combat High Energy Laser Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will continue developing and validating laser and beam control technologies with extremely low SWaP to integrate on a risk-reduction platform. Will begin defining risk-reduction system for data collection and validation of technology suitability for Close-Combat Platform risk reduction effort. ***FY 2021 Plans:*** Will continue developing and validating laser and beam control technologies with extremely low SWaP to integrate on a risk reduction platform. Will conduct modeling & simulation to inform experimentation and conduct experimentation with instrumented risk-reduction platform for collecting and analyzing data for validation of technology and assessing its suitability for a Close Combat Platform risk reduction effort. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Increased cost in FY21 to refine models for CCHEL mission set and completes platform instrumentation and data collection tools that enables the risk reduction demonstration.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.240	-
Accomplishments/Planned Programs Subtotals	-	7.357	8.696

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*	**Project (Number/Name)** AE2 / *Unconventional Countermeasures-Survivability Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AE2: *Unconventional Countermeasures-Survivability Tech*	-	0.000	5.756	6.588	-	6.588	3.976	2.160	2.180	2.180	0.000	22.840

Note

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

A. Mission Description and Budget Item Justification

This Project designs and develops technologies to deter tactical surveillance and targeting by adversarial area denial systems and munitions. The Project investigates methods to increase survivability of critical assets against precision-guided near-peer advanced weapons threats, investigates and develops tonedown methods for signature management, and computationally develops novel countermeasures. This Project also develops a suite of high-fidelity, physics-based modeling and simulation tools for the design and development of unconventional countermeasures and survivability enhancers applicable to a wide range of operating environments.

Work in this Project complements PE 0603466A (Air and Missile Defense Advanced Technology)/Project AE3 (Unconventional Countermeasures-Survivability Advanced Technology).

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

Work in this Project is performed by the Engineer Research and Development Center (ERDC) and coordinated with the Army Futures Command (AFC).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Development of Unconventional Countermeasures for Enhanced Survivability (DeUCES)	-	3.168	4.230
Description: This effort investigates and develops countermeasures to defeat near-peer advanced weapons through computational modeling and enhanced tonedown measures.			
FY 2020 Plans: Complete experiments to develop novel tonedown techniques for critical fixed and semi-fixed assets to include novel application of commercial off the shelf materials.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*	**Project (Number/Name)** AE2 / *Unconventional Countermeasures-Survivability Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will conduct experiments to investigate techniques and materials for hyperspectral and tone down response and validate their use on critical assets as either integrated systems or temporary coatings for various environments. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Increased resources required in FY21 as this Science and Technology (S&T) Project builds toward transition from Applied Research to Advanced Technology Development portion of the effort.			
Title: Model-Based Assessment of Sensors and Countermeasures ***Description:*** This effort develops a suite of high-fidelity, physics-based modeling and simulation tools for the design and development of unconventional countermeasures with electro-optical/infrared (EO/IR) sensors for a wide range of operating environments; develops tools for threat detection and object identification using machine learning tools for EO/IR sensors; and builds superior target/threat recognition algorithms. ***FY 2020 Plans:*** Develop sensor models for EO/IR sensors and generate imagery for machine learning tools; will develop and optimize an initial unconventional countermeasure capability. ***FY 2021 Plans:*** Will develop and investigate computational environments for sensor-algorithm performance in a range of simulated environments. These efforts will couple large scale physics based sensor models with high resolution environmental test beds to develop medium-to short-range sensor performance models for guided weapons. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects the planned lifecycle of this effort.	-	2.515	2.358
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.073	-
Accomplishments/Planned Programs Subtotals	-	5.756	6.588

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*	**Project (Number/Name)** AE2 / *Unconventional Countermeasures-Survivability Tech*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*	**Project (Number/Name)** AE4 / *Collaborative ISR Sensors Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
AE4: *Collaborative ISR Sensors Technology*	-	0.000	3.517	2.989	-	2.989	3.316	3.394	2.198	0.000	0.000	15.414

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602270A Electronic Warfare Technology
* Project 906 Tactical Electronic Warfare Applied Research

A. Mission Description and Budget Item Justification

This Project directly supports Army Modernization Priority Air and Missile Defense capabilities by designing and developing Intelligence, Surveillance, Reconnaissance (ISR) sensors with extended range threat detection and enhanced survivability by cooperative sensing while on-the-move.

Work in this Project complements PE 0603466A Air and Missile Defense Advanced Technology / Project AD6 Next Generation Fires Radar Advanced Technology.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Collaborative ISR Sensors Technology	-	3.357	2.989
Description: Design and develop ISR sensors with extended range threat detection and enhanced survivability by cooperative sensing while on-the-move.			
FY 2020 Plans: Will investigate techniques and waveforms that enable Multi-Domain Battlefield (Land/Air) operations between platforms with non-traditional Radar sensing. Will research the best technology enablers that provide a Multi- Domain capability while identifying novel techniques to exploit those enablers. Investigate methods that improve platform and sensor survivability against emerging future threats in a spectrally complex environment.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*	**Project (Number/Name)** AE4 / *Collaborative ISR Sensors Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will continue to develop techniques and waveforms for clutter suppression and synchronization between platforms with non-traditional Radar sensing; will develop algorithms to perform data collections to validate test cases; will research non-traditional Radar sensing; and will continue to research best technology enablers for Multi-Domain Operations capability ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects the planned lifecycle of this effort.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.160	-
Accomplishments/Planned Programs Subtotals	-	3.517	2.989

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602150A / *Air and Missile Defense Technology*	**Project (Number/Name)** BN6 / *Advanced Weapons Components (CA)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BN6: *Advanced Weapons Components (CA)*	-	0.000	45.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	45.000

Note

Congressional Interest Item funding provided for Advanced Weapons Components.

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Advanced Weapon Components.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Sustainable Energy Materials and Manufacturing ***FY 2020 Plans:*** Sustainable Energy Materials and Manufacturing	-	12.000
Congressional Add: High-Energy Laser Hardware in the Loop ***FY 2020 Plans:*** High-Energy Laser Hardware in the Loop	-	20.000
Congressional Add: COE in High-Energy Laser and Optical Technology ***FY 2020 Plans:*** COE in High-Energy Laser and Optical Technology	-	3.000
Congressional Add: Cybersecurity and Supply Chain Risk Management ***FY 2020 Plans:*** Cybersecurity and Supply Chain Risk Management	-	10.000
Congressional Adds Subtotals	-	45.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	80.424	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	80.424
47A: *AERON & ACFT Wpns Tech*	-	52.748	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	52.748
47B: *Veh Prop & Struct Tech*	-	10.676	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	10.676
47C: *ROTORCRAFT COMPONENT TECHNOLOGIES (CA)*	-	17.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	17.000

Note

In Fiscal Year (FY) 2020 this Program Element (PE) is realigned with continuity of effort to the following PE:
* 0602148A Future Vertical Lift Technology

A. Mission Description and Budget Item Justification

This PE conducts air vehicle component design, fabrication and evaluation to enable Army aviation transformation. Emphasis is on developing aviation platform technologies to enhance manned and unmanned air vehicle combat and combat support operations for attack, reconnaissance, air assault, survivability, logistics and command and control missions. Project 47A researches and evaluates components and subsystems for air vehicles in the areas of aviation and aircraft weapons technology. Project 47B researches and evaluates components and subsystems for air vehicles in the areas of propulsion and structures. Focus areas include: engines & drive trains; rotors & vehicle management systems; platform design & structures; aircraft & occupant survivability; aircraft weapons & sensors; maintainability & sustainability; and unmanned & optionally manned systems.

Work in this PE contributes to the Army Science and Technology (S&T) air systems portfolio and is fully coordinated with efforts in PE 0603003A (Aviation-Advanced Technology), PE 0602624A (Weapons and Munitions Technology), PE 0602303A (Missile Technology) and PE 0603710A (Night Vision Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering S&T focus areas and the Army Modernization Strategy. Work in this PE is performed by the United States Army Futures Command (AFC).

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	81.805	0.000	0.000	-	0.000
Current President's Budget	80.424	0.000	0.000	-	0.000
Total Adjustments	-1.381	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.381	-			

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2019	FY 2020
Project: 47C: *ROTORCRAFT COMPONENT TECHNOLOGIES (CA)*		
Congressional Add: *Adaptive Flight Control Technology Development*	6.986	-
Congressional Add: *Aviation and Missile Technology Transfer and Innovation*	5.000	-
Congressional Add: *UH-60 Main Rotor Blade Modernization*	5.000	-
Congressional Add: *FY 2018 NDAA SEC 825 MDAP Cost Overrun*	0.014	-
Congressional Add Subtotals for Project: 47C	17.000	-
Congressional Add Totals for all Projects	17.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47A / *AERON & ACFT Wpns Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
47A: *AERON & ACFT Wpns Tech*	-	52.748	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	52.748

Note

In Fiscal Year (FY) 2020 this Project is being realigned to Program Element (PE) 0602148A Future Vertical Lift Projects:
* Project AI5 Next Gen Tactical UAS TD Technology
* Project AI7 Alternative Concept Engine Technology
* Project AJ2 Next Generation Rotorcraft Transmission Technology
* Project AJ4 Digital Vehicle Management and Control Technology
* Project AJ6 Advanced Rotors Technology
* Project AJ8 Experimental and Computational Aeromechanics Techn
* Project AK1 UAS Survivability Technology
* Project AK2 Aviation Survivability Technology
* Project AK9 Adv Teaming for Tactical Aviation Oper
* Project AL2 High Performance Computing for Rotorcraft App Tech
* Project AM2 Aircraft and Aircrew Protection Technology

A. Mission Description and Budget Item Justification

This Project designs and evaluates technologies for Army/Department of Defense (DoD) vertical lift and unmanned air systems to increase strategic and tactical mobility/deployability, improve combat effectiveness, increase aircraft and crew survivability, and improve combat sustainability. Areas of research address desired characteristics applicable to all aviation platforms, such as enhanced rotor efficiencies, improved survivability, increased structure and airframe capability, improved engine performance, improved sustainability, improved mission avionics performance, and reduced cost. This Project leverages work accomplished in collaboration with the National Aeronautics and Space Administration (NASA). Technologies within this Project transition to advanced technology development programs with application to future, as well as current, Army/DoD aircraft systems.

Work in this Project is fully coordinated with PE 0603003A (Aviation Advanced Technology) and work in this Project related to aircraft weapons integration is also fully coordinated with PE 0602624A (Weapons and Munitions Technology), PE 0602303A (Missile Technology), and PE 0603710A (Night Vision Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering Science and Technology (S&T) focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Platform Design & Structures Technologies	3.897	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47A / *AERON & ACFT Wpns Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: Enables survivable, sustainable rotorcraft configurations by conceiving of and evaluating critical aviation technologies using design and analysis methods with greater modeling fidelity with an ultimate goal of reducing the timelines associated with overall design of new aircraft. Introduces high fidelity methodology for improved performance and design predictions earlier in the development and acquisition process. Use physics of failure modeling and coupled discipline analysis to drastically improve component and system reliability.			
Title: Rotors & Vehicle Management Technologies ***Description:*** Design and investigate advanced airfoil and rotor blade technologies, including active control elements, to support goals of increased hover and cruise efficiency. Design and evaluate advanced flight control and vehicle management component technologies to support goals of increased maneuverability, reliability, and reduced weight and cost.	10.855	-	-
Title: Engine and Drives Technologies ***Description:*** Design and evaluate advanced turboshaft engine component technologies to support goals of reduced fuel consumption, engine size, weight, and cost, as well as improved reliability and maintainability. Design and evaluate advanced drive system component technologies to support multi-speed transmissions, lighter weight gearboxes, and reduced costs, while improving reliability and maintainability	7.392	-	-
Title: Survivability For Degraded Visual Environment (DVE) Operations ***Description:*** Research advanced sensor and cockpit display technologies to provide ability to maintain terrain and obstacle situational awareness during aircraft induced (brown-out & white-out) and environmentally induced (rain, snow, smog, fog, smoke, low light, etc.) DVE.	0.489	-	-
Title: Mission Systems ***Description:*** Investigate technologies to reduce susceptibility and vulnerability of aircraft to damage from threats or accidents, as well as technologies to defeat small arms, rocket and missile threats. Investigate advanced engagement concepts of organically launch systems from Army aviation platforms.	11.643	-	-
Title: Unmanned and Optionally Manned Technologies ***Description:*** Design and Develop advanced Manned-Unmanned Teaming (MUM-T) concepts to expand aviation mission sets that include resupply, reconnaissance, surveillance, electronic warfare, protection, medical evacuation and attack. Design and develop collaborative and cooperative algorithms to support the goal of intelligent teaming for manned-unmanned operations. Design and develop advanced unmanned aircraft systems (UAS) components to support goal of improved UAS performance. When applicable, technologies in this area are leveraged to support mitigation of DVE.	18.430	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47A / *AERON & ACFT Wpns Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***Description:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.042	-	-
Accomplishments/Planned Programs Subtotals	52.748	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602211A / *Aviation Technology*	Project (Number/Name) 47B / *Veh Prop & Struct Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
47B: *Veh Prop & Struct Tech*	-	10.676	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	10.676

Note

In Fiscal Year (FY) 2020 this Project is being realigned to
Program Element (PE) 06022148A Future Vertical Lift Projects:
* Project AI9 Future UAS Engine Technology
* Project AK9 Adv Teaming for Tactical Aviation Operations Tech
* Project AL4 High Speed and Efficient VTOL Vehicle Technology
* Project AL5 Air Vehicle Structures and Dynamics Technology

A. Mission Description and Budget Item Justification

This Project investigates engine, drive train, and airframe enabling technologies such as multifunctional materials, fluid mechanics and high temperature, high strength, low cost shaft materials. Additional areas of research include platform, aerodynamic, transmission, and control technologies for implementation in autonomous Unmanned Aerial Systems (UAS) and failure analysis and prediction models and techniques to support a "zero maintenance helicopter" concept.

Work in this Project complements and is fully coordinated with PE 0603003A (Aviation Advanced Technology) and leverages basic research performed in PE 0601104A (University and Industry Research Centers) / Project H09 (Robotics Collaborative Technology Alliance).

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Rotor and Structure Technology ***Description:*** Devise improved tools and methodologies to more accurately design for improved component reliability and durability, resulting in platforms that are lighter in weight and less costly to acquire and maintain. Investigate rotors and structures to significantly improve rotorcraft range and speed.	2.635	-	-
Title: Air Vehicle Propulsion and Power Technology ***Description:*** Applied research investigating engine and drivetrain technologies for Army manned and unmanned air vehicles. Research, investigates, and conducts experiments to develop, innovate, and validate advanced models and improved methods for propulsion system components and configurations to enable improvements in power density, efficiency, reliability and life cycle cost for increasing performance and capabilities of Army aviation systems.	1.968	-	-
Title: Micro/Small Scale Unmanned Aerial Systems	3.630	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47B / *Veh Prop & Struct Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: Develop means to maximize the endurance of Soldier and robot portable aerial Intelligence, Surveillance, and Reconnaissance (ISR) assets through investigation of technologies such as adaptive materials for wings/airframes and an array of behaviors, spanning low-level reflexive controls through higher intelligence path and mission planning.			
Title: Aviation Component Failure Modeling ***Description:*** Develop failure analysis and prediction models and techniques to support a "zero maintenance helicopter" concept. Work is coordinated with Aviation component and system reliability efforts in PE 0602211A (Aviation Technology) / Project 47A (Aeron & Acft Wpns Tech) at the United States (US) Army Aviation and Missile Research, Development and Engineering Center.	0.974	-	-
Title: High Speed & Efficient Vertical Take-off and Landing ***Description:*** Perform Vertical Take-Off and Landing (VTOL) research investigations in propulsion, aeromechanics and platform technologies to explore, innovate and combine the most promising technologies to enable more efficient hover, high-speeds, and greater maneuverability at longer ranges for Army aviation. Reconfigurable and adaptive technologies include hover rotor systems that can achieve high speed, low drag; aerodynamic lift technologies capable of higher speed and efficient cruise; and convertible propulsion technologies to deliver more efficient hover and higher speed cruise power.	1.461	-	-
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***Description:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.008	-	-
Accomplishments/Planned Programs Subtotals	10.676	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47C / *ROTORCRAFT COMPONENT TECHNOLOGIES (CA)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
47C: *ROTORCRAFT COMPONENT TECHNOLOGIES (CA)*	-	17.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	17.000

Note

Congressional Increase for Fiscal Year 2019 (FY19).

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Rotorcraft Component Technologies.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Adaptive Flight Control Technology Development ***FY 2019 Accomplishments:*** Adaptive Flight Control Technology Development	6.986	-
Congressional Add: Aviation and Missile Technology Transfer and Innovation ***FY 2019 Accomplishments:*** Aviation and Missile Technology Transfer and Innovation	5.000	-
Congressional Add: UH-60 Main Rotor Blade Modernization ***FY 2019 Accomplishments:*** UH-60 Main Rotor Blade Modernization	5.000	-
Congressional Add: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***FY 2019 Accomplishments:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.014	-
Congressional Adds Subtotals	17.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602213A / *C3I Applied Cyber*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	0.000	18.947	18.816	-	18.816	15.351	14.654	39.198	49.617	0.000	156.583
2CY: *Information Trust Technology*	-	0.000	1.222	1.220	-	1.220	0.516	0.000	0.000	0.000	0.000	2.958
3CY: *Network Access and Effects Technology*	-	0.000	3.945	4.191	-	4.191	6.727	6.882	6.959	6.959	0.000	35.663
5CY: *Offensive Cyber Operations (OCO) Mirror Technology*	-	0.000	1.000	0.999	-	0.999	0.999	0.999	1.010	1.010	0.000	6.017
CY1: *Information Assurance and Network Resiliency Tech*	-	0.000	3.357	3.488	-	3.488	3.473	3.875	4.145	4.186	0.000	22.524
CY6: *Autonomous Cyber Technology*	-	0.000	3.733	6.133	-	6.133	0.795	0.000	24.154	34.532	0.000	69.347
CY8: *Cyber Security App Research and Exper Partner Tech*	-	0.000	2.733	2.785	-	2.785	2.841	2.898	2.930	2.930	0.000	17.117
CY9: *Decoy and Deterrence Technology*	-	0.000	2.957	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	2.957

Note

In Fiscal Year (FY) 2020 this Program Element (PE) is realigned with continuity of effort from the following PEs:
* PE 0602270A Electronic Warfare Technology
* PE 0602782A Command, Control, Communications Technology
* PE 0602783A Computer and Software Technology

A. Mission Description and Budget Item Justification

This PE designs cyber architectures, software, tools, and techniques to enable Cyber Electromagnetic Activities (CEMA) to counter adversary communications and harden the Army's tactical communications networks against cyber attacks. For offensive cyber effort against adversary communications, efforts investigate capabilities to identify and capture data traversing targeted networks for detection, identification, exploitation, direction finding, geolocation, and denial of service. For defensive cyber efforts hardening the Army's tactical network, efforts also investigates and applies robust cyber security technologies and techniques to advance software, algorithms and protocols utilized within tactical networks to protect against nation state level cyber attacks and maintain Warfighter confidence in network information by hardening the blue force attack surface.

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	**Date:** February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602213A / *C3I Applied Cyber*

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

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

B. Program Change Summary ($ in Millions)	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**
Previous President's Budget	0.000	18.947	21.718	-	21.718
Current President's Budget	0.000	18.947	18.816	-	18.816
Total Adjustments	0.000	0.000	-2.902	-	-2.902
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	-2.902	-	-2.902

Change Summary Explanation

FY21 decrease related to Science and Technology financial restructuring.

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602213A / *C3I Applied Cyber*	**Project (Number/Name)** 2CY / *Information Trust Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
2CY: *Information Trust Technology*	-	0.000	1.222	1.220	-	1.220	0.516	0.000	0.000	0.000	0.000	2.958

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
Program Element (PE) 0602782A Command, Control, Communications Technology:
* Project CY2 Applied Defensive Cyber

A. Mission Description and Budget Item Justification

This Project develops defensive cyber technology to ensure that data traversing the network remains verified and has not been modified through unauthorized means.

Work in this Project complements PE 0603457A (C3I Cyber Advanced Development) / Project 8CY (Information Trust Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Information Trust Technology	-	1.222	1.220
Description: This effort develops defensive cyber technology to ensure that data traversing the network remains verified and has not been modified through unauthorized means.			
FY 2020 Plans: Will investigate and leverage message integrity checking functionality similar to those adopted by cross domain security solutions to analyze fixed format message types against well documented data specifications; explore use of machine learning and virtual containment techniques to develop software-based application services that ensure the integrity of a message's data, origin, and chain of custody as it traverses the network; and investigate de-centralized lightweight blockchain techniques that can be leveraged to ensure a secure distributed ledger of messages and associated risk with automated analysis of attempted malicious modification.			
FY 2021 Plans: Will design and conduct experiments with specification based fixed format message checking and machine learning based integrity services that ensure the integrity of a message?s data, origin, and chain of custody as it traverses the network; mature the trust score architecture that can provide real time analytics of the data through distributed processing and minimization of			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602213A / *C3I Applied Cyber*	**Project (Number/Name)** 2CY / *Information Trust Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
network traffic; and design suitable de-centralized lightweight block chain algorithms that can be leveraged to ensure a secure distributed ledger of messages and associated risk with automated analysis of attempted malicious modification. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Accomplishments/Planned Programs Subtotals	-	1.222	1.220

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602213A / *C3I Applied Cyber*	**Project (Number/Name)** 3CY / *Network Access and Effects Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
3CY: *Network Access and Effects Technology*	-	0.000	3.945	4.191	-	4.191	6.727	6.882	6.959	6.959	0.000	35.663

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602270A Electronic Warfare Technology
* Project CYB Applied Offensive Cyber

A. Mission Description and Budget Item Justification

This Project investigates the application of machine learning technologies to assist in capability development and mission execution processes with respect to Offensive Cyber Operations (OCO)/Radio Frequency (RF) Enabled capabilities.

Work in this Project complements PE 0603457A (C3I Cyber Advanced Development) / Project 9CY (Network Access and Effects Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Applied OCO Techniques and Analytics	-	3.945	3.945
Description: This effort investigates the application of machine learning technologies to assist in capability development and mission execution processes with respect to OCO/RF Enabled capabilities.			
FY 2020 Plans: Research use of non-kinetic effects (e.g. protocol-based/system-based/RF-enabled) against emerging commercial/military and hybrid technologies used in Adversary Command, Control, Communication, Computers, and Intelligence (AC4I) systems; investigate remote software delivery and software execution against AC4I; and research the ability to reduce cyber/RF operator cognitive burden using machine learning based decision aids and target pairing (e.g., cyber and RF enabled).			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602213A / *C3I Applied Cyber*	**Project (Number/Name)** 3CY / *Network Access and Effects Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will research techniques to expedite protocol-based vulnerability discovery against emerging targets; and investigate OCO capabilities that focus on commonalities between targets of interest in support of non-kinetic OCO effects against emerging hybrid commercial/military technologies in AC4I systems.			
Title: Command, Control and Communications Attack ***Description:*** This effort investigates RF Enabled access and effects against adversary Command, Control, Communication, Computers, and Intelligence (C4I) systems executed from agile OCO/RF Enabled firing platforms. ***FY 2021 Plans:*** Will research target design commonalities in support of non-kinetic Radio Frequency-enabled access and effects against emerging hybrid commercial/military technologies used within AC4I systems. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Planned research for electronic warfare technologies in support of Cyber.	-	-	0.246
Accomplishments/Planned Programs Subtotals	-	3.945	4.191

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602213A / *C3I Applied Cyber*	**Project (Number/Name)** 5CY / *Offensive Cyber Operations (OCO) Mirror Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
5CY: *Offensive Cyber Operations (OCO) Mirror Technology*	-	0.000	1.000	0.999	-	0.999	0.999	0.999	1.010	1.010	0.000	6.017

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
Program Element (PE) 0602270A Electronic Warfare Technology
* Project CYB Applied Offensive Cyber

A. Mission Description and Budget Item Justification

This Project designs, creates, evaluates, and applies emerging cyber techniques and cyber situational awareness technologies to enhance Army capabilities. This Project leverages behavioral Modeling and Simulation to mitigate risks and investigates cyber collection and mapping technologies to offer real time cyber situational awareness to enable interpretation of current threats and predict future enemy activities. This allows commanders to develop operational courses of action in time to act decisively and in a pre-emptive manner.

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Offensive Cyber Operations Mirror Technology	-	1.000	0.999
Description: Will research emerging internet technologies that enable Offensive Cyber operations infrastructure maneuver within neutral (gray) cyberspace environment; conduct experiments within a modeling and simulation environment (to include behavioral components) to enhance rapid offensive cyber developed capabilities, cyber mission rehearsal, and training.			
FY 2020 Plans: Research emerging internet technologies that enable Offensive Cyber operations infrastructure maneuver within neutral (gray) cyberspace environment; and conduct experiments within a modeling and simulation environment (to include behavioral components) to enhance rapid offensive cyber developed capabilities, cyber mission rehearsal, and training.			
FY 2021 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602213A / *C3I Applied Cyber*	**Project (Number/Name)** 5CY / *Offensive Cyber Operations (OCO) Mirror Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will investigate novel methods for an enhanced discrete event simulator required for future modeling and simulation environments, at scale with advanced behavioral models; and experiment on the traffic shaping mirror capability components. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Accomplishments/Planned Programs Subtotals	-	1.000	0.999

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602213A / *C3I Applied Cyber*	**Project (Number/Name)** CY1 / *Information Assurance and Network Resiliency Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
CY1: *Information Assurance and Network Resiliency Tech*	-	0.000	3.357	3.488	-	3.488	3.473	3.875	4.145	4.186	0.000	22.524

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
Program Element (PE) 0602783A Computer and Software Technology:
* Project Y10 Computer/Info Sci Tech

A. Mission Description and Budget Item Justification

This Project develops and characterizes techniques for detecting, disrupting, understanding and predicting complex adversarial activities and their impacts for developing agile, adaptive maneuvers in defense of information and networks (Agile Cyber Maneuver and Resilience); hardware, algorithms, and methods that jointly adapt to support uninterrupted communications (Autonomous Tactical Networking).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Information Assurance and Network Resiliency Technology	-	3.357	3.488
Description: This effort designs and characterizes software for the protection of information and networks in wireless tactical environments. The goal is to develop software algorithms that detect and defeat malicious activities of adversaries in bandwidth-constrained tactical networks.			
FY 2020 Plans: Design and develop networking architectures with novel features such as the exploitation of quantum entanglement or the inclusion of a supervisory layer that has global protocol-stack visibility and reduced operational speed requirements so as to be able to effect joint optimization of complex objective functions across all network layers; and develop experimental methods and systems and execute experimentation to investigate and characterize protocols enabled by such networking architectures.			
FY 2021 Plans: Will develop and implement novel methods for network control that include joint optimization of the layers of the protocol stack, the adaptation of multiple diverse communication and networking modalities, and the optimization with respect to generalized mission-centric objectives; develop, implement, and experimentally validate protocols that feature improvements in energy usage,			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602213A / *C3I Applied Cyber*	**Project (Number/Name)** CY1 / *Information Assurance and Network Resiliency Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
jamming resistance, and security; utilize machine learning methods to detect, predict, and disrupt adversarial activities; and develop techniques to defend against adversarial influence of machine learning (ML) based Intrusion Detection Systems (IDS) methods. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Planned program increase to continue research in network resiliency.			
Accomplishments/Planned Programs Subtotals	-	3.357	3.488

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602213A / *C3I Applied Cyber*	Project (Number/Name) CY6 / *Autonomous Cyber Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
CY6: *Autonomous Cyber Technology*	-	0.000	3.733	6.133	-	6.133	0.795	0.000	24.154	34.532	0.000	69.347

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
Program Element (PE) 0602782A Command, Control, Communications Technology:
* Project CY2 Applied Defensive Cyber

A. Mission Description and Budget Item Justification

This Project investigates and applies robust cyber security techniques and applications to advanced communications and networking devices, software, algorithms and protocols utilized within wireless tactical networks to protect against nation state level cyber effects and maintain Warfighter confidence in network information, resources, identities and mission partners by hardening the blue force attack surface.

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Autonomous Cyber Technology	-	3.733	6.133

Description: This effort develops defensive cyber technology to secure the automated network decisions (e.g., Primary, Alternate, Contingency, and Emergency (PACE)) and defend against adaptive, autonomous cyber attacks at machine speed.

FY 2020 Plans:
Develop an interoperable Artificial Intelligence/Machine Learning (AI/ML) based cyber defense decision aid architecture supporting warfighter planning; and investigate concepts that support development of generative network algorithms and neural network software to simulate adversarial attacks on AI/ML algorithms that can be utilized to ensure trustworthiness of autonomous network configuration decisions and mitigate any vulnerable decisions.

FY 2021 Plans:
Will mature technology and validate the interoperable AI/ML based cyber defense decision aid architecture supporting warfighter planning; and mature and validate generative network algorithms and neural network software to simulate adversarial attacks on

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602213A / *C3I Applied Cyber*	**Project (Number/Name)** CY6 / *Autonomous Cyber Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
AI/ML algorithms that can be utilized to ensure trustworthiness of autonomous network configuration decisions and mitigate any vulnerable decisions. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding in this effort increased to support the maturity and complexity of the AI/ML based cyber decision aid architecture.			
Accomplishments/Planned Programs Subtotals	-	3.733	6.133

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602213A / *C3I Applied Cyber*	**Project (Number/Name)** CY8 / *Cyber Security App Research and Exper Partner Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
CY8: *Cyber Security App Research and Exper Partner Tech*	-	0.000	2.733	2.785	-	2.785	2.841	2.898	2.930	2.930	0.000	17.117

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
Program Element (PE) 0602782A Command, Control, Communications Technology:
* Project CY2 Applied Defensive Cyber

A. Mission Description and Budget Item Justification

This Project investigates cyber electromagnetic activities (CEMA), cyber security devices, software and techniques to harden wireless communications networks against cyber-attacks and new mobile networking protocols that afford resilience within our networks to autonomically 'fight through' and/or evade hostile cyber effects.

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Cyber Security Applied Research & Experimentation Partner (AREP) Technology	-	2.733	2.785
Description: This effort will take innovative basic research theories from the Cyber Collaborative Research Alliance (CRA) and experimentally validate the hypothesis and create proof-of-concept defensive cyber software implementations. Work being accomplished under PE 0602782A (Command, Control, Communications Technology) / Project H92 (Communications Technology) complements this effort, and this effort is fully coordinated with the Army Research Lab Cyber Security Collaborative Research Alliance, PE 0601121A (Cyber Collaborative Research Alliance) / Project CB5 (Cyber Collaborative Research Alliance).			
FY 2020 Plans: Continue to investigate stealthy virtual machine migration techniques that incorporate machine learning to improve obscuring of critical network traffic that supports dynamic distribution of software; investigate efficient machine learning techniques the can potentially enhance high fidelity cyber decoys with adversarial action prediction qualities; investigate machine learning techniques that can detect and counter adversarial machine learning; investigate machine learning and game theoretical techniques that can operate on limited or 'dirty' data sets to make decisions on attack disruption; and investigate techniques that			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602213A / *C3I Applied Cyber*	**Project (Number/Name)** CY8 / *Cyber Security App Research and Exper Partner Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
can reason on adversarial intent and potential predict adversary next move. ***FY 2021 Plans:*** Will conduct experiments with efficient machine learning techniques and multi-user behavior modeling to enhance fidelity of cyber decoys and enable pre-predicting of adversarial action; conduct experiments with artificial intelligence (AI) techniques that can reason on adversarial tactic techniques and procedures (TTP's) to detect and counter adversarial machine learning; and conduct experiments with AI and game theoretical techniques that can operate on limited or 'dirty' data sets (data set that contains errors such as redundant, duplicate or incomplete data) to enable agility of tactical network assets to counter threat. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Accomplishments/Planned Programs Subtotals	-	2.733	2.785

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army												Date: February 2020
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602213A / *C3I Applied Cyber*				Project (Number/Name) CY9 / *Decoy and Deterrence Technology*			
COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
CY9: *Decoy and Deterrence Technology*	-	0.000	2.957	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	2.957

Note

In Fiscal Year 2020 (FY20) this Project is realigned from:
Program Element (PE) 0602782A Command, Control, Communications Technology
* Project CY2 Applied Defensive Cyber

In FY21 this Project is Eliminated.

A. Mission Description and Budget Item Justification

This Project designs technologies to counter enemy cyber threats by delaying, disrupting, and deterring their ability to successfully attack tactical systems, applications, and critical data.

Work in this Project complements PE 0603457A (C3I Cyber Advanced Development) / Project 7CY (Decoy and Deterrence Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Decoy and Deterrence Technology ***Description:*** This effort designs technologies to counter enemy cyber threats by delaying, disrupting, and deterring their ability to successfully attack tactical systems, applications, and critical data. ***FY 2020 Plans:*** Investigate concepts and mechanisms utilizing pattern matching algorithms and steganographic authentication; and investigate suitable machine learning and intelligent data transfer throttling techniques that can be closely coupled with cyber sensors to enable rapid generation and control of cyber decoys. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This Project in eliminated in FY21.	-	2.957	-
Accomplishments/Planned Programs Subtotals	-	2.957	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602213A / *C3I Applied Cyber*	**Project (Number/Name)** CY9 / *Decoy and Deterrence Technology*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602270A / *Electronic Warfare Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	25.127	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	25.127
906: *Tactical Electronic Warfare Applied Research*	-	19.962	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	19.962
CYB: *Applied Offensive Cyber*	-	5.165	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.165

Note

In Fiscal Year (FY) 2020 this Program Element (PE) is realigned with continuity of effort to the following PEs:
* 0602146A Network C3I Technology
* 0602148A Future Vertical Lift Technology
* 0602150A Air and Missile Defense Technology
* 0602213A C3I Applied Cyber

A. Mission Description and Budget Item Justification

This PE designs and validates electronic warfare (EW) components, both hardware and software, that deny, disrupt, or degrade the enemy's use of the electromagnetic spectrum for offensive or defensive operations. This is accomplished through the investigation of electronic support measures (ESM); countermeasures against communications systems and networks; the design and fabrication of sensors used to identify and locate threat forces in an asymmetric environment; and threat warning and electronic countermeasures (ECM) against munitions sensors, missile guidance systems, targeting systems, and explosive hazards. Project 906 supports protection of high-value ground platforms, aircraft and the Soldier from threat surveillance and tracking systems, imaging systems, and advanced radio frequency (RF)/electro-optical (EO)/infrared (IR) guided missiles, artillery, and smart munitions. Information fusion research addresses sensor correlation and fusion, relationship discovery, and management services through use of automated processing, as well as software that applies higher level reasoning techniques to support automated combat assessment. Project 906 also supports research and application of key EW sensors, direction finders and jammers to intercept, locate, and disrupt current and emerging communications and non-communications threat emitters to provide vital quality combat information directly to users in a timely and actionable manner. It focuses on detection of threat sensors and emitters associated with weapon systems, targeting systems and command, control, communications, computers, and intelligence systems and networks. Project CYB designs, creates, evaluates, and applies emerging cyber techniques and cyber situational awareness technologies to enhance Army capabilities and to mitigate risks and investigates cyber collection and mapping technologies to offer real time cyber situational awareness to enable interpretation of current threats and predict future enemy activities.

Work in this PE complements PE 0602120A (Sensors and Electronic Survivability), PE 0602782A (Command, Control, Communications Technology), PE 0603270A (Electronic Warfare Technology), and PE 0603772A (Advanced Tactical Computer Science and Sensor Technology); and is coordinated with PE 0603710A (Night Vision Advanced Technology) and PE 0603794A (C3 Advanced Technology).

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	**Date:** February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602270A / *Electronic Warfare Technology*

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

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

B. Program Change Summary ($ in Millions)	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**
Previous President's Budget	25.558	0.000	0.000	-	0.000
Current President's Budget	25.127	0.000	0.000	-	0.000
Total Adjustments	-0.431	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.431	-			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602270A / *Electronic Warfare Technology*	**Project (Number/Name)** 906 / *Tactical Electronic Warfare Applied Research*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
906: *Tactical Electronic Warfare Applied Research*	-	19.962	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	19.962

Note

In Fiscal Year (FY) 2020 this Project is realigned to:
Program Element (PE) 0602146A Network C3I Technology
* Project AN7 COE - Every Receiver is a Sensor Technology
* Project AO2 Stand-In Advanced RF Effects (STARE)
* Project AQ2 EW Techniques Technology
* Project AQ3 Network Access and Effects
* Project AV3 Foundational S&T for Network C3I Technology
PE 0602148A Future Vertical Lift Technology
* Project AK2 Aviation Survivability Technology

A. Mission Description and Budget Item Justification

This Project designs, fabricates, evaluates, and applies key electronic warfare (EW)/information operations technologies to enhance platform survivability (to include ground combat vehicles, aircraft, and the dismounted Soldier) and to intercept, track and locate current and emerging threat munitions, communications and non-communications threat emitters. This Project applies recent advances in radio frequency (RF), infrared (IR), and electro-optical (EO) sensors and jamming sources to detect, locate, deceive, and jam threats (to include radar directed target acquisition systems, target-tracking sensors, surface-to-air missiles (SAMs), air-to-air missiles (AAMs), top attack weapons, and electronically fused munitions). This project also pursues the ability to neutralize improvised explosive devices. This project designs information systems to provide vital, quality combat information directly to users in a timely, actionable manner in accordance with concepts for future force intelligence operations. This Project investigates RF collection and mapping technologies to offer real time emitter detection, location, and identification. In addition, this project enables a remote capability to disrupt, deny, or destroy threat communication signals and enables fusion (automated assimilation and synthesis) of battlefield intelligence data to enable interpretation of current threats and future enemy activities. This allows commanders to develop operational courses of action in time to act decisively and in a pre-emptive manner.

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

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

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

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602270A / *Electronic Warfare Technology*	**Project (Number/Name)** 906 / *Tactical Electronic Warfare Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Data Analytics for Situational Awareness ***Description:*** This effort researches and designs spectrum sensing, electronic sensing and intelligence collection technologies and analytics to enhance overall situational understanding within a contested battlespace. Efforts focus on developing the analytics necessary to taking advantage of the expanding number of data sources available by leveraging existing tactical receivers and other tactical data feeds.	2.946	-	-
Title: Offensive Information Operations Technologies ***Description:*** This effort designs, codes and evaluates techniques for RF network mapping, surgical disruption and unobtrusive operations in the presence of host nation networks. Electronic warfare capabilities include detection, location, classification, mapping and disruption of RF networks and providing data to a user.	2.470	-	-
Title: Multispectral Threat Warning and Countermeasures, formerly Multispectral Threat Warning ***Description:*** This effort investigates and evaluates software and warning sensor/countermeasure components to increase probability to detect and defeat current and evolving small arms and man-portable air defense system (MANPADS) type threats for aviation platforms using modeling and simulation (M&S) and hardware in the loop (HWIL) simulations. Work being accomplished under PE 0603270A (Electronic Warfare Technology) / K16 (Non-Commo Ecm Tech Dem) complements this effort.	6.800	-	-
Title: Multi-Function Intelligence, Surveillance and Reconnaissance Technologies ***Description:*** This effort investigates and codes software algorithms and techniques to intelligently integrate tactical Intelligence, Surveillance, and Reconnaissance (ISR) sensors, improve their individual performance and increase the effectiveness of battlespace awareness/intelligence data in an area of operations. Efforts focus on networking of sensors and open, scalable common RF architectures for terrestrial and aerial sensors.	7.242	-	-
Title: Multi Function Electronic Warfare (MFEW) Technique Development ***Description:*** This effort investigates and develops EW techniques critical to countering communications, such as networked command and control nodes or improvised explosive device threats, and radars, such as ground surveillance and counter-fire radars. The techniques developed are system agnostic and applicable to a wide variety of EW and electronic countermeasure applications, and they can be used to improve the performance and expand the functionality of both current and future EW system capabilities.	0.500	-	-
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***Description:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.004	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602270A / *Electronic Warfare Technology*	**Project (Number/Name)** 906 / *Tactical Electronic Warfare Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Accomplishments/Planned Programs Subtotals	19.962	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602270A / *Electronic Warfare Technology*	**Project (Number/Name)** CYB / *Applied Offensive Cyber*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
CYB: *Applied Offensive Cyber*	-	5.165	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.165

Note

In Fiscal Year (FY) FY 2020 this Project is realigned to:
Program Element (PE) 0602213A C3I Applied Cyber
* Project 3CY Network Access and Effects Technology
* Project 5CY Offensive Cyber Operations (OCO) Mirror Technology

A. Mission Description and Budget Item Justification

This Project designs, creates, evaluates, and applies emerging cyber techniques and cyber situational awareness technologies to enhance Army capabilities. This Project leverages behavioral Modeling and Simulation to mitigate risks and investigates cyber collection and mapping technologies to offer real time cyber situational awareness to enable interpretation of current threats and predict future enemy activities. This allows commanders to develop operational courses of action in time to act decisively and in a pre-emptive manner.

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Offensive Information Operations Technologies ***Description:*** This effort designs, codes and evaluates cyber architectures, software, tools and techniques that identify and capture data traversing targeted networks for the purpose of Cyber Electro Magnetic Activity (CEMA) or otherwise countering adversary communications. Cyber capabilities include detection, identification, exploitation, direction finding (DF), geolocation, and denial of service.	5.164	-	-
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***Description:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.001	-	-
Accomplishments/Planned Programs Subtotals	5.165	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602270A / *Electronic Warfare Technology*	**Project (Number/Name)** CYB / *Applied Offensive Cyber*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	90.496	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	90.496
214: *Missile Technology*	-	48.996	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	48.996
G05: *MISSILE TECHNOLOGY INITIATIVES (CA)*	-	41.500	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	41.500

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is realigned with continuity of effort to the following PEs:
PE 0602147A Long Range Precision Fires Technology
PE 0602148A Future Vertical Lift Technology
PE 0602150A Air and Missile Defense Technology

A. Mission Description and Budget Item Justification

This PE designs, fabricates and evaluates advanced component technologies for tactical missiles, rockets, guided munitions, and their launch systems in order to increase lethality, precision, and effectiveness under adverse battlefield conditions while reducing system cost, size and weight. Major goals in Project 214 include enhancing the survivability of the munition, launch and fire control systems and increasing kill probabilities against diverse targets.

Work in this PE is complimentary to PE 0603313A (Missile and Rocket Advanced Technology) and fully coordinated with PE 0602307A (Advanced Weapons Technology), PE 0602618A (Ballistics Technology), PE 0602624A (Weapons and Munitions Technology), PE 0603004A (Weapons and Munitions Advanced Technology), PE 0602782A (Command, Control, Communications Technology), and PE 0708045A (End Item Industrial Preparedness Activities).

Beginning in FY20, work in this PE is complimentary to PE 0603464A (Long Range Precision Fires Advanced Technology), PE 0603465A (Future Vertical Lift Advanced Technology), PE 0603463A (Network/C3I Advanced Technology), and PE 0603466A (Air and Missile Defense Advanced Technology).

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

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	**Date:** February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*

B. Program Change Summary ($ in Millions)	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**
Previous President's Budget	91.647	0.000	0.000	-	0.000
Current President's Budget	90.496	0.000	0.000	-	0.000
Total Adjustments	-1.151	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.151	-			

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2019**	**FY 2020**
Project: G05: *MISSILE TECHNOLOGY INITIATIVES (CA)*		
Congressional Add: *Carbon composite warhead research*	6.500	-
Congressional Add: *Additive manufacturing to support optimized long range precision fires*	10.000	-
Congressional Add: *Air vehicle development and sustainment*	15.000	-
Congressional Add: *Enterprise science and technology prototyping*	10.000	-
Congressional Add Subtotals for Project: G05	41.500	-
Congressional Add Totals for all Projects	41.500	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602303A / *Missile Technology*	Project (Number/Name) 214 / *Missile Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
214: *Missile Technology*	-	48.996	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	48.996

Note

In Fiscal Year (FY) 2020 this Project is realigned to:
Program Element (PE) 0602147A Long Range Precision Fires Technology:
* Project AE7 Land-Based Anti-Ship Missile (LBASM) Technology
* Project AF1 Long Range Maneuverable Fires (LRMF) Technology
* Project AF3 Extended Range Propulsion Technology
* Project AF5 Simulation and Aerostructures Technology
* Project AF6 Structures Technology
* Project AF7 Warhead Integration Technology
* Project AF8 Affordable Extended Range Precision Technology
* Project AF9 Precision and Accuracy Technology
* Project AG1 Missile Electronics Technology
* Project AG2 Information and Signal Processing Technology
* Project AG9 Multiple Simul Engagement Technologies (MSET) Tech
* Project AH2 Single Multi-mission Attack Missile (SMAM) Technol
PE 06020148A Future Vertical Lift Technology:
* Project AK4 Multi-Role Small Guided Missile Technology
PE 0602150A Air and Missile Defense Technology:
* Project AD3 Maneuver Air Defense Technology
* Project AD5 Next Generation Fires Radar Technology
* Project AD7 Missile Fire Control Sensors Technology

A. Mission Description and Budget Item Justification

This Project designs, fabricates, and evaluates missile and rocket component technologies that support demonstration of affordable, lightweight, highly lethal missiles and rockets. Major areas of research include: guidance, navigation, and controls; target acquisition systems; multi-spectral seekers; high-fidelity simulations; sustainment; aerodynamics and structures; launch systems, fire control technologies; payloads; and propulsion including research to help solve the insensitive munitions requirements. A theme embedded throughout the efforts in this project is smaller, lighter, and cheaper (SLC) missile technology to reduce the cost and logistical burden of precision munitions.

This Project supports the Army Science and Technology Lethality and Command, Control, Communications and Intelligence (C3I) portfolios.

Major products of this Project transition to PE 0603313A (Missile and Rocket Advanced Technology).

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*	**Project (Number/Name)** 214 / *Missile Technology*

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Missile Seeker Technology ***Description:*** This effort focuses on the design, fabrication and evaluation of missile seekers, sensors, and software. The goal is to increase affordability and performance of missile seekers through improvement of algorithms, imaging, and thermal management.	4.648	-	-
Title: Missile Guidance, Navigation and Controls Technologies ***Description:*** This effort designs, fabricates and evaluates guidance, navigation, and control systems and software, as well as information and signal processing systems for rocket and missile applications. Goals of this effort include more affordable missile guidance; miniaturization of guidance electronics; maintaining performance in Global Positioning System (GPS) denied environments; improved image processing; improved missile power systems; improved communication with ground and other systems; technologies to track and respond to threat and offensive munition swarms.	8.225	-	-
Title: Missile Fire Control Systems, Sustainment, Simulations, and Launchers ***Description:*** This effort designs and evaluates fire control and tracking sensor technologies for area protection and air defense, technologies to increase the longevity of developed missiles and reliability, advanced simulations to increase performance and reduce size, weight, and cost of missile systems, and launcher technology to deliver effects from air and ground platforms.	6.851	-	-
Title: Missile Propulsion, Structures, Lethality, and Aerodynamic Technology ***Description:*** This effort designs, fabricates, evaluates and tests missile enabling technologies including: advanced missile propulsion with reduced launch signatures; increased lethality and reduced weight and size using advanced materials and additive manufacturing. Missile Propulsion, Structures and Lethality efforts are in coordination with PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) and PE 0602624A (Weapon and Munition Technology) / Project H28 (Warheads/Energetics Technologies).	7.142	-	-
Title: Multi-Role Missile Technology ***Description:*** This effort evaluates critical technology and designs component for future affordable rockets and missiles to provide overwhelming defeat of conventional and asymmetrical threats in all environments.	1.728	-	-
Title: Air Defense Missile Technologies ***Description:*** This effort evaluates and provides technologies and performs necessary trade studies to provide the key components for maturation and demonstration of air defense missiles to counter threats such as UAS and cruise missile systems.	8.300	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*	**Project (Number/Name)** 214 / *Missile Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Affordable Precision Missile Enabling Technology ***Description:*** This effort focuses on the studies, design, establishment, fabrication, and evaluation of components and subsystems critical to produce affordable discriminate extended range precision missiles. Critical component technologies include: advanced propulsion, seekers/sensors, fire control, datalink, guidance, navigation and controls, and airframes.	2.223	-	-
Title: Long Range Fires Enabling Technology ***Description:*** This effort focuses on performing the necessary trade studies, and designing, establishing, fabricating and evaluating critical component technologies needed to support a long range fires capability.	6.552	-	-
Title: Cooperative Engagement Lethality Technology ***Description:*** This effort investigates critical component technology and designs for future missiles that provide expeditionary, scalable, precision strike and loiter capability to rapidly defeat hard targets and swarming or disbursed threats at the Tactical Edge. Provides the missile technology path to supervised autonomous target detection and cooperative engagement/manned-unmanned teaming for offensive, multiple simultaneous engagement capabilities.	3.300	-	-
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***Description:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.027	-	-
Accomplishments/Planned Programs Subtotals	48.996	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*	**Project (Number/Name)** G05 / *MISSILE TECHNOLOGY INITIATIVES (CA)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
G05: *MISSILE TECHNOLOGY INITIATIVES (CA)*	-	41.500	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	41.500

Note

Congressional Program increase for Fiscal Year 2019 (FY19).

A. Mission Description and Budget Item Justification

This is a Congressional Interest Item.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Carbon composite warhead research ***FY 2019 Accomplishments:*** Carbon composite warhead research	6.500	-
Congressional Add: Additive manufacturing to support optimized long range precision fires ***FY 2019 Accomplishments:*** Additive manufacturing to support optimized long range precision fires	10.000	-
Congressional Add: Air vehicle development and sustainment ***FY 2019 Accomplishments:*** Air vehicle development and sustainment	15.000	-
Congressional Add: Enterprise science and technology prototyping ***FY 2019 Accomplishments:*** Enterprise science and technology prototyping	10.000	-
Congressional Adds Subtotals	41.500	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602307A / *Advanced Weapons Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	43.454	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	43.454
042: *High Energy Laser Technology*	-	28.454	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	28.454
NA5: *Advanced Weapons Components (CA)*	-	15.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	15.000

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is realigned with continuity of effort to the following PE:
* 0602150A Air and Missile Defense Technology

A. Mission Description and Budget Item Justification

This PE investigates enabling technologies for High Energy Laser (HEL) weapons. Project 042 develops component technologies such as efficient, high energy, solid state lasers; advanced beam control components; and lethality / effectiveness measurements that enable better models and simulations for future HEL weapon designs.

Work in this PE is related to, and fully complements, efforts in PE 0601101A (In-House Laboratory Independent Research), PE 0602120A (Sensors and Electronic Survivability), PE 0603004A (Weapons and Munitions Advanced Technology) and Air Force PE 0602890F (HEL Research).

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

Work is performed by the United States Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC / ARSTRAT) in Huntsville, AL, and the High Energy Laser Systems Test Facility at White Sands Missile Range, NM.

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	**Date:** February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602307A / *Advanced Weapons Technology*

B. Program Change Summary ($ in Millions)	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**
Previous President's Budget	44.468	0.000	0.000	-	0.000
Current President's Budget	43.454	0.000	0.000	-	0.000
Total Adjustments	-1.014	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.014	-			

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2019**	**FY 2020**
Project: NA5: *Advanced Weapons Components (CA)*		
Congressional Add: *High energy laser technology*	10.000	-
Congressional Add: *COE in high energy and laser and optical technology*	5.000	-
Congressional Add Subtotals for Project: NA5	15.000	-
Congressional Add Totals for all Projects	15.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602307A / *Advanced Weapons Technology*	**Project (Number/Name)** 042 / *High Energy Laser Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
042: *High Energy Laser Technology*	-	28.454	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	28.454

Note

In Fiscal Year (FY) 2020 this Project is realigned to:
Program Element (PE) 0602150A Air and Missile Defense Technology
* Project AC9 High Energy Laser Tactical Vehicle Demonstrator Technology
* Project AD2 High Energy Laser (HEL) Enabling and Support Technology
* Project AD9 Close Combat High Energy Laser Technology

A. Mission Description and Budget Item Justification

This Project investigates and develops advanced technologies for High Energy Laser (HEL) weapon systems to enable more efficient laser systems with greater power output. This includes technologies to support development of alternate laser sources, precision optical pointing and tracking components, adaptive optics to overcome laser degradation due to atmospheric effects, and thermal management systems to remove excess heat. In addition, this effort validates laser lethality performance and conducts analyses against a variety of targets and investigates the impact of low-cost laser countermeasures. This project includes laboratory efforts for HEL applied research as well as concepts analysis for United States Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT) Technical Center competencies in directed energy, missile defense, and space technical areas. Solid State Laser (SSL) efforts continue to leverage other funds provided by the HEL Joint Technology Office (JTO), the Air Force, and the Navy to develop multiple technical approaches that reduce program risk and maintain competition.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Solid State Laser Effects ***Description:*** This effort provides the underlying data required to support high energy laser weapon system effectiveness analyses. This activity includes the full spectrum of lethality testing from fundamental physics investigations to the engagement of flying targets in relevant scenarios. This activity is primarily executed at the Solid State Laser Testbed (SSLT) facility at White Sands Missile Range, New Mexico.	4.051	-	-
Title: Advanced Beam Control Component Development ***Description:*** This effort investigates technologies to enable lighter, more agile beam control systems that are robust enough to be used in Army platforms. This work is done in collaboration with the HEL JTO and other Services.	17.419	-	-
Title: High Efficiency Laser Development	5.951	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602307A / *Advanced Weapons Technology*	**Project (Number/Name)** 042 / *High Energy Laser Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort develops component technologies that increase SSL efficiencies, which will lead to reductions in size and weight for multiple subsystems that greatly improve the ability to integrate SSL systems into Army weapon platforms. This work is done in collaboration with the HEL JTO and other Services. Selected laser design will be fabricated and integrated onto an Army platform to demonstrate a high energy laser system functionality and is fully coordinated with PE 0603004A (Weapons and Munitions Advanced Technology) / Project L96 (High Energy Laser Technology Demo).			
Title: HEL Research and Development and Concepts Analysis Laboratories ***Description:*** This effort focuses on developing in-house expertise through SSL assessments and starting in FY15, other USASMDC/ARSTRAT technical core competencies, including air and missile defense, responsive space, and small satellites.	1.033	-	-
Accomplishments/Planned Programs Subtotals	28.454	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602307A / *Advanced Weapons Technology*	**Project (Number/Name)** NA5 / *Advanced Weapons Components (CA)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
NA5: *Advanced Weapons Components (CA)*	-	15.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	15.000

Note

Congressional increase for Program increase

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Advanced Weapons Components applied research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: High energy laser technology ***FY 2019 Accomplishments:*** High energy laser technology	10.000	-
Congressional Add: COE in high energy and laser and optical technology ***FY 2019 Accomplishments:*** COE in high energy and laser and optical technology	5.000	-
Congressional Adds Subtotals	15.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	28.623	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	28.623
C90: *Advanced Distributed Simulation*	-	27.046	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	27.046
D02: *Modeling & Simulation For Training And Design*	-	1.577	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.577

Note

In Fiscal Year (FY) 2020 this Program Element (PE) is realigned with continuity of effort from the following PEs:
* PE 0602143A Soldier Lethality Technology
* PE 0602145A Next Generation Combat Vehicle Technology

A. Mission Description and Budget Item Justification

This PE investigates and designs enabling technologies to create effective training capabilities for the Warfighter and supports the underpinning technologies and understanding to establish architecture standards and interfaces necessary for realizing the Army vision of creating a realistic synthetic "electronic battlefield" environment for use across the spectrum of doctrine, organization, training, leader development, materiel, personnel, and facilities (DOTLM-PF). Project C90 focuses on advancing component technologies required for real time interactive linking within and among constructive, virtual, and live simulation and training by refining technologies for advanced distributed interactive simulation. Project D02 further develops concepts for immersive training and learning environments with the Institute for Creative Technologies (ICT) at the University of Southern California, Los Angeles, California.

Work in this PE complements and is fully coordinated with PE 0601104A (University and Industry Research Centers), PE 0602785A (Manpower/Personnel/Training Technology), PE 0602786A (WarfighterTechnology), PE 0602787A (Medical Technology), PE 0603001A (Warfighter Advanced Technology), PE 0603007A (Manpower, Personnel and Training Advance Technology), PE 0603015A (Next Generation Training & Simulation Systems) and PE 0603710A (Night Vision Advanced Technology).

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

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	28.470	0.000	0.000	-	0.000
Current President's Budget	28.623	0.000	0.000	-	0.000
Total Adjustments	0.153	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	1.063	-			
• SBIR/STTR Transfer	-0.910	-			

Change Summary Explanation

Funds reprogrammed out for higher priority Army requirements.

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*	**Project (Number/Name)** C90 / *Advanced Distributed Simulation*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
C90: *Advanced Distributed Simulation*	-	27.046	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	27.046

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
Program Element (PE) 0602143A Soldier Lethality Technology
* Project BC3 Soldier Decision Making & Comms Performance Tech
* Project BC7 Training Technology (Other than STE)
* Project BE8 Synthetic Training Environment (STE) Technology)
PE 0602145A Next Generation Combat Vehicle Technology
* Project BF6 Crew Augmentation and Optimization Tech

A. Mission Description and Budget Item Justification

This Project investigates and designs enabling technologies for advancing distributed simulation and training (live, virtual and constructive) environments. This includes networking of models representing complex human behavior, complex data interchange between simulations, synthetic natural environments, medical training simulations, ground platform training, adaptive tutoring for individuals and teams, and collaborative training. The Project researches the ability to create a virtual representation of combined arms environments, with the Warfighter-in-the-loop that constructive (event driven) simulations cannot simulate.

Efforts in this Project support the Under Secretary of Defense for Research and Engineering Science and Technology priorities and the Army Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Live and Medical Training Technologies ***Description:*** Included in this effort will be the development of new medical training simulations to train medical personnel across all levels of care and the development of live training technology that can be applied across all military levels and training environments.	3.185	-	-
Title: Adaptive Tutoring ***Description:*** This effort investigates adaptive tutoring and immersive learning environments with social simulations to conduct kinetic and non-kinetic training for individuals and teams.	2.800	-	-
Title: Training Effectiveness Research	1.333	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*	**Project (Number/Name)** C90 / *Advanced Distributed Simulation*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort will research and develop simulation architectures, tools, and models that can represent current and future semi and fully autonomous systems. The architecture, tools and models will enable the evaluation of the training impacts (i.e., cognitive, physiological, and team coordination) of future autonomous systems and technologies on individual, crew, and unit tasks. The training demands of systems that are increasingly complex, intelligent, and self-adaptive far exceed those of legacy systems that require training of primarily procedural tasks. This is compounded by parallel increases in autonomy and responsibility at lower echelons.			
Title: Rapid Soldier Capability Enhancement - Training ***Description:*** Research the relationship of augmentation agents and Soldier performance & behavior. Investigate the effects of augmentation agents (perceptual, cognitive, and/or physical), used either individually or coupled as a system of agents, on Soldier performance, resilience, and training during operationally relevant tasks. Development of guidelines and models for designing and employing augmentation agents. Implementation of guidelines will enhance augmented Soldier performance.	2.100	-	-
Title: Synthetic Natural Environments ***Description:*** This effort investigates and develops tools and methods to improve the speed, fidelity and delivery of synthetic terrain and environmental data to support Training Aid Devices (TADs), simulation and mission rehearsal systems.	2.200	-	-
Title: Mixed Reality Research ***Description:*** This effort investigates and develops enabling virtual and augmented reality simulation and training technologies to support future training environments and Army senior leader initiatives in Decide Faster, Asymmetric Vision, and Manned-Unmanned Teaming capabilities. These technologies support the Army capability needs for enhanced dismounted Soldier performance in complex urban environments. Identification of future technologies will be done in concurrence with the core modeling and simulation enablers for megacities.	4.000	-	-
Title: Cyber for Training Simulations ***Description:*** This effort investigates and develops analytical capabilities to more accurately characterize, model, and predict human behavior related to Cyber Electromagnetic Activities (CEMA) events from the tactical to the strategic level.	2.750	-	-
Title: Artificial Intelligence ***Description:*** This effort investigates artificial intelligence techniques to develop intelligent, human-like, virtual characters to maximize and accelerate Soldier learning in future simulation and training applications. This effort also develops novel methods for joint human/intelligent agent learning and decision making.	1.500	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*	**Project (Number/Name)** C90 / *Advanced Distributed Simulation*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Synthetic Training Environment Acceleration ***Description:*** This effort designs and develops technologies that will transition to advanced technology development in order to enable a Synthetic Training Environment which is a single, interconnected training system in which units from squad through Army Service Component Command (ASCC) can train in the most appropriate domain - live, virtual, constructive, and gaming, or in all four simultaneously.	3.171	-	-
Title: Advancing Distributed Simulations ***Description:*** Effort supports key foundational areas for advancing distributed simulations and training, to explore technical solutions in Augmented Reality/Virtual Reality (AR/VR) network optimization and data compression, realistic AR/VR software tool for physical world simulation, and design of Internet of Things (IoT) and Artificial Intelligence/Machine Learning (AI/ML) training assessment tools.	4.000	-	-
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***Description:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.007	-	-
Accomplishments/Planned Programs Subtotals	27.046	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*	**Project (Number/Name)** D02 / *Modeling & Simulation For Training And Design*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
D02: *Modeling & Simulation For Training And Design*	-	1.577	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.577

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
Program Element (PE) 0602143A Soldier Lethality Technology
* Project BC7 Training Technology (Other than STE)
* Project BE8 Synthetic Training Environment (STE) Technology

A. Mission Description and Budget Item Justification

This Project transitions basic research into applied research. This Project investigates and designs training applications to enable the Army to train any time and any place. Efforts include designing virtual humans that embody natural language, speech recognition in noisy environments, gesture, gaze, and conversational speech. Techniques and methods are assessed for integrating different sensory cues into virtual environments that result in enhanced training and leader development. The project leverages the capabilities of industry and the research and development community through the synthesis of creativity and technology, including work at the Army Research Institute and the Army Research Laboratory.

Efforts in this Project support the Under Secretary of Defense for Research and Engineering Science and Technology (S&T) priorities and the Army Modernization Strategy.

Developed technologies and techniques are transitioned for maturation and demonstration to PE 0603015A (Next Generation Training & Simulation Systems) / Project S28 (Immersive Learning Environments).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Immersive Technology Environments ***Description:*** Conduct applied research that enables responsive and reconfigurable environments that immerse human senses such as sight, sound, and touch in mixed reality environments to include physical elements providing touch and feel to simulate objects such as obstacles and walls.	1.052	-	-
Title: Immersive Technology Techniques ***Description:*** This effort develops tools, techniques and technologies for improving the immersion of human senses within simulation environments and therefore creating enhanced realism.	0.525	-	-
Accomplishments/Planned Programs Subtotals	1.577	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*	**Project (Number/Name)** D02 / *Modeling & Simulation For Training And Design*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	102.899	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	102.899
C05: *Armor Applied Research*	-	20.912	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	20.912
H77: *National Automotive Center*	-	11.721	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	11.721
H91: *Ground Vehicle Technology*	-	36.266	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	36.266
T26: *Ground Vehicle Technologies (CA)*	-	34.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	34.000

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is realigned with continuity of effort to:
* PE 0602145A (Next Generation Combat Vehicle Technology).

A. Mission Description and Budget Item Justification

This PE researches, designs, and evaluates combat and tactical vehicle automotive technologies that enable the Army to have a lighter, more survivable, more mobile and more deployable force. Project C05 (Armor Applied Research) investigates, researches, and evaluates advanced ground vehicle design and occupant protection technologies in such areas as armor concepts, ballistic defeat mechanisms, blast mitigation, survivability modeling and simulation (M&S), hit avoidance, kill avoidance, safety, sensors, counter measures, instrumentation, and survivability packaging concepts to achieve superior survivability/protection for Soldiers and military ground vehicles. Survivability technologies will be designed for integration into/with the Modular Active Protection System (MAPS). Project H77 (National Automotive Center), which was chartered by the Secretary of the Army to conduct shared government and industry, or "dual use", technology programs to leverage commercial investments in automotive technology research and development for Army ground combat and tactical vehicle applications. Project H91 (Ground Vehicle Technology) designs, matures, and evaluates a variety of innovative and enabling technologies in the areas of electrical power, thermal management, propulsion, mobility, power for advanced survivability, vehicle diagnostics, fuels, lubricants, water purification, intelligent systems, autonomy enabled systems, and other component technologies to enhance the mobility, power and energy, and reduce the logistic chain of combat and tactical vehicles. This PE executes the Army's Combat Vehicle Prototyping (CVP) program to mature, integrate, and demonstrate ground vehicle leap ahead technologies in support of future combat vehicles.

In FY18/FY19 work in this PE is related to, and fully coordinated with, PEs 0602105A (Materials Technology), 0602618A (Ballistics Technology, Robotics Technology), 0602705A (Electronics and Electronic Devices), 0602716A (Human Factors Engineering Technology), 0603005A (Combat Vehicle and Automotive Advanced Technology), 0603125A (Combating Terrorism Technology Development), 0603734A (Military Engineering Advanced Technology), and 0708045A (Manufacturing Technology). Beginning in FY20, work in this PE is related to, and fully coordinated with PE 0602145A (Next Generation Combat Vehicle Technology) and PE 0603462A (Next Generation Combat Vehicle Advanced Technology).

Work in this PE is coordinated with the United States Marine Corps, the Naval Surface Warfare Center, and other ground vehicle developers within the Defense Advanced Research Projects Agency (DARPA) and the Departments of Energy, Commerce, and Transportation.

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*

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

The Ground Portfolio technology investments are creating a layered vehicle protection suite including Active Protection (Hard-Kill and Soft-Kill) capabilities supported by robust advanced armor (Enhanced Survivability).

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	104.404	0.000	0.000	-	0.000
Current President's Budget	102.899	0.000	0.000	-	0.000
Total Adjustments	-1.505	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.505	-			

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2019	FY 2020
Project: T26: *Ground Vehicle Technologies (CA)*		
Congressional Add: *Program Increase - Duel-use Technology Programs*	9.000	-
Congressional Add: *Program Increase - Advanced Materials Development for Survivability*	14.982	-
Congressional Add: *Program Increase - High Electrified Vehicles and Infrastructure Connectivity*	4.000	-
Congressional Add: *Prohgram Increase - Structural Thermoplastics for Vehicles*	6.000	-
Congressional Add: *FY 2018 NDAA SEC 825 MDAP Cost Overrun*	0.018	-
Congressional Add Subtotals for Project: T26	34.000	-
Congressional Add Totals for all Projects	34.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** C05 / *Armor Applied Research*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
C05: *Armor Applied Research*	-	20.912	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	20.912

Note

In Fiscal Year (FY) 2020, the Project will be realigned to:
Program Element (PE) 0602145A Next Generation Combat Vehicle Technology:
* Project BG6 Advanced Concepts for Active Defense Technology
* Project BH9 Protection for Autonomous Systems Tech

A. Mission Description and Budget Item Justification

This Project investigates, researches, and evaluates advanced ground vehicle design and occupant protection technologies in such areas as armor concepts, ballistic defeat mechanisms, blast mitigation, survivability modeling and simulation (M&S), improved situational awareness, hit avoidance, kill avoidance, safety, sensors for blast, crash and rollovers, instrumentation and survivability packaging concepts to achieve superior survivability/protection for Soldiers and ground combat and tactical vehicles. Survivability/protection technologies are being investigated to meet anticipated ground combat and tactical vehicle survivability objectives. Additionally, this project focuses on analysis, modeling, and characterization of potential survivability solutions that could protect against existing and emerging threats. This analysis is used to aid in the identification of technologies to enter maturation and development in PE 0603005A (Combat Vehicle and Automotive Advanced Technology) / Project 221 (Combat Vehicle Survivability).

This Project supports Army Science and Technology efforts in the Ground Maneuver portfolio.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Advanced Armor Development: ***Description:*** The objective of this effort is to design, integrate and validate performance of advanced armor systems to defeat single and multiple chemical energy (CE) and kinetic energy (KE) emerging threats for combat and tactical vehicles. These systems include base armor (small arms / medium caliber, opaque and transparent B-kits), applique armor (passive / reactive / active multi-threat C-kits), multifunctional armor, and adaptive and cooperative armors.	9.826	-	-
Title: Blast Mitigation: ***Description:*** This effort designs, fabricates and evaluates advanced survivability and protection capabilities, tools and technologies to improve protection against vehicle mines, improvised explosive devices (IEDs) and other underbody threats and crash events. This effort also designs and evaluates technologies purposed for protecting the occupant such as seats and restraints. Blast and crash mitigation technologies are further investigated and matured in such areas as active and passive	2.430	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** C05 / *Armor Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
exterior/hull/cab/kits, interior energy absorbing capabilities for seats, floors, restraints, sensors for active blast mitigating technologies and performance evaluation, M&S, experimentation and instrumentation.			
Title: Improved Situational Awareness for Ground Platforms ***Description:*** This effort investigates situational awareness (SA) technologies and architectures to improve occupant and vehicle survivability in all conditions and environments to include degraded visual environments (DVE) for ground vehicles. This effort also investigates and analyzes electronic architectures to enable the efficient integration of DVE systems such as intra-vehicle data and video networks, SA input/output devices, and associated software architectures and interfaces.	4.499	-	-
Title: Protection for Autonomous Systems ***Description:*** This effort investigates and develops materials, concepts, and devices to protect autonomous systems against emerging threats. This effort also evaluates methods to apply the advanced protection materials, concepts, and devices onto autonomous systems to prevent disabling or destroying sensors, electronics, and mechanical components, or physical exploitation of subsystems.	2.384	-	-
Title: Active Defense Technologies ***Description:*** This effort investigates, analyzes, and designs active hard-kill (physical countermeasure) and soft-kill (non-kinetic countermeasure such as electronic jamming or spoofing) protection Active Protection System (APS) components for future integration onto tactical and combat vehicle platforms. This effort also investigates, designs, and development active, modular components and controls for APS vehicle protection and associated architectures and interfaces.	1.762	-	-
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***Description:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.011	-	-
Accomplishments/Planned Programs Subtotals	20.912	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H77 / *National Automotive Center*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H77: *National Automotive Center*	-	11.721	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	11.721

Note

In Fiscal Year (FY) 2020, funding for this Project is realigned to
Program Element (PE) 0602145A Next Generation Combat Vehicle Technology:
* Project BJ3 (Hydrogen Based Combat System Technology)
* Project BI9 (Vehicle System Security Technology)
* Project BH5 (Platform Electrification and Mobility Tech)
* Project BI4 (Materials Application and Integration Tech)

A. Mission Description and Budget Item Justification

This Project funds the National Automotive Center (NAC), which was chartered by the Secretary of the Army to conduct shared government and industry (dual use) technology programs to leverage commercial investments in automotive technology research and development for Army ground combat and tactical vehicle applications. Primary thrusts for this activity include advanced power and energy technologies for tactical and non-tactical ground vehicles, electric infrastructure and alternative energy for installations and bases, vehicle networking and connectivity to maximize overlap between commercial and military requirements. Active outreach to industry, academia and other government agencies develops new thrust areas for this Project to maximize shared commercial and government investment.

This Project supports Army Science and Technology efforts in the Ground Maneuver portfolio.

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

The Ground Portfolio technology investments are maturing powertrain technologies to provide a fuel efficient engine/power plant capability that is common across the fleet to reduce fuel, training, maintenance and parts requirements.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Power, Energy and Mobility: ***Description:*** This effort investigates dual use power, energy, and mobility technologies leveraging commercial and academic investment to military application. This effort focuses on technologies such as lightweight composite materials, electrification of engine accessories, alternative fuels, hybrid vehicle architectures, and compact electrical power generation in order to maximize common investment to meet Army ground vehicle requirements.	4.224	-	-
Title: Dual Use Technologies:	7.472	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H77 / *National Automotive Center*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort investigates, researches and evaluates ground vehicle technologies with both military and commercial applications such as renewable energy technologies, electrical power management between vehicles and the grid, alternative fuels, new human machine interfaces, and advanced vehicle networking, automation, and secure communication (telematics). This effort maximizes commercial technology investment for military applications in line with the National Automotive Center's Charter. Collaborations with industry, universities and other government agencies on standards writing for joint applications will facilitate this activity.			
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***Description:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.025	-	-
Accomplishments/Planned Programs Subtotals	11.721	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 / *Ground Vehicle Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H91: *Ground Vehicle Technology*	-	36.266	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	36.266

Note

In Fiscal Year (FY) 2020, this Project realigns to
Program Element (PE) 0602145A Next Generation Combat Vehicle Technology:
* Project BH5 Platform Electrification & Mobility Tech
* Project BF1 Autonomous Ground Resupply Tech
* Project BF3 Combat Vehicle Robotics Tech)
* Project BF6 Crew Augmentation and Optimization Tech

A. Mission Description and Budget Item Justification

This Project designs, develops, and evaluates a variety of innovative enabling technologies in the areas of vehicle concepts, virtual prototyping, electronic controls, electrical power, thermal management, propulsion, mobility, survivability, vehicle diagnostics, fuels, lubricants, water purification, intelligent systems, autonomy enabled systems, and other component technologies for application to combat and tactical vehicles.

This Project supports Army Science and Technology efforts in the Ground Maneuver portfolio.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Propulsion and Thermal Systems: ***Description:*** This effort researches, designs and evaluates high power density engines and transmission systems needed to offset increasing combat vehicle weights (armor), improved fuel economy (fuel cost & range), and reduced cooling system burden (size, heat rejection). This effort also researches and matures thermal management technologies and systems including heat energy recovery, propulsion and cabin thermal management sub systems to utilize waste heat energy and meet objective power and mobility requirements on all ground vehicles. Lastly, this effort maximizes efficiencies within propulsion and thermal systems to reduce burden on the vehicle while providing the same or greater performance capability.	5.909	-	-
Title: Power Management Technologies: ***Description:*** This effort investigates power management technologies, software, and implementation approaches. Technologies include Alternating Current (AC) to Direct Current (DC) inverters, DC converters, solid state circuit protection, power distribution,	2.586	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 / *Ground Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
and automated control of complete power systems. Special emphasis has been placed on developing high temperature capable power electronics, leading to the use of Silicon Carbide (SiC) in the above technologies.			
Title: Power Electronics, Hybrid Electric and Onboard Vehicle Power (OBVP) Components: ***Description:*** This effort researches, develops and evaluates technologies to increase onboard vehicle electric power to enable vehicle systems such as advanced survivability systems, situational awareness systems, advanced computing, and the Army network. This effort researches, designs and evaluates high temperature and efficient power generation components to provide increased electrical power and reduced thermal loads using high operating temperature switching devices and advanced electrical generation components such as integrated starter generators and integrated starter alternators. This effort also researches, designs and evaluates advanced control techniques for power generation components to make these systems more efficient, increase electrical power output and reduce thermal loads.	0.233	-	-
Title: Intelligent Systems Technology Research: ***Description:*** This effort investigates improved operations of manned platforms through the application of sensing and autonomy technologies developed for unmanned systems such as maneuver and tactical behavior algorithms, driver assist techniques, autonomy kits, advanced navigation and planning, vehicle self-protection, local situational awareness, advanced perception, vehicle and pedestrian safety, active safety, and robotic command and control.	9.919	-	-
Title: Energy Storage: ***Description:*** This effort investigates novel advanced ground vehicle energy storage devices such as advanced chemistry batteries and ultra-capacitors for starting, lighting, and ignition and silent watch requirements for powering vehicle electronics and communications systems with main engine off. Develop and test energy storage devices to meet harsh military requirements that far exceed commercial requirements such as extreme temperature operation (46 to +71C), ballistic shock and vibration, and electromagnetic interference (in accordance with Military Standard 810G). Designs and develops advanced batteries to reduce battery volume and weight while improving battery energy and power densities within the same footprint and standardized form factor of current batteries (6T) to enhance logistics.	2.451	-	-
Title: Crew Station ***Description:*** This effort focuses on crew size reduction and crew stations tailored to mission and soldier needs through the utilization of emerging human interaction technologies, automations, machine intelligence and the provision of cohesive domain personalization to permit soldiers to achieve leap ahead performance beyond today?s constrained ground vehicle environment.	4.690	-	-
Title: Unmanned Ground Systems Research	10.478	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 / *Ground Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort researches, designs, and develops technologies that enable scalable integration of multi domain teamed robotic and autonomous system capabilities supporting Army combat formations. Investigate behaviors and algorithms to mature functions that detect and classify risks and threats, reduce burden on the Soldier operator, and validate initial safety procedures for armed Unmanned Ground Vehicles (UGVs) in contested, austere and congested environments. Investigates increased situational awareness needed for a high degree of survivability and lethality for complex maneuvers. Mature government owned autonomy architecture to enable iterative software capability upgrades for systems. Conduct experiments in static environment with multiple live and simulated manned unmanned vehicles with evolving threats. Investigate behaviors and hardware needed to rapidly learn, adapt & reason faster than the adversary.			
Accomplishments/Planned Programs Subtotals	36.266	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** T26 / *Ground Vehicle Technologies (CA)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
T26: *Ground Vehicle Technologies (CA)*	-	34.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	34.000

Note

Congressional increase.

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Ground Vehicle Technology applied research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Program Increase - Duel-use Technology Programs ***FY 2019 Accomplishments:*** Program Increase - Duel-use Technology Programs	9.000	-
Congressional Add: Program Increase - Advanced Materials Development for Survivability ***FY 2019 Accomplishments:*** Program Increase - Advanced Materials Development for Survivability	14.982	-
Congressional Add: Program Increase - High Electrified Vehicles and Infrastructure Connectivity ***FY 2019 Accomplishments:*** Program Increase - High Electrified Vehicles and Infrastructure Connectivity	4.000	-
Congressional Add: Prohgram Increase - Structural Thermoplastics for Vehicles ***FY 2019 Accomplishments:*** Prohgram Increase - Structural Thermoplastics for Vehicles	6.000	-
Congressional Add: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***FY 2019 Accomplishments:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.018	-
Congressional Adds Subtotals	34.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	86.737	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	86.737
H80: *Survivability And Lethality Technology*	-	76.737	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	76.737
HB1: *SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)*	-	10.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	10.000

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is realigned with continuity of effort to the following PEs:
* PE 0602141A (Lethality Technology)
* PE 0602143A (Soldier Lethality Technology)
* PE 0602145A (Next Generation Combat Vehicle Technology)
* PE 0602147A (Long Range Precision Fires Technology)

A. Mission Description and Budget Item Justification

This PE investigates and evaluates materials and technologies, and designs and develops methodologies and models required to enable enhanced lethality and survivability. Project H80 focuses on applied research of lightweight armors and protective structures for the Soldier and vehicles; kinetic energy active protection; crew and components protection from ballistic shock and mine-blast; insensitive propellants/munitions formulations; novel multi-function warhead concepts; affordable precision munitions design; techniques, methodologies, and models to analyze combat effectiveness and identify potential technology vulnerabilities; and technologies, methods, and tools for injury prediction of vehicle occupants during under-body blast events.

Work in this PE makes extensive use of high performance computing and experimental validation and builds on research transitioned from PE 0601102A (Defense Research Sciences) / Project H42 (Materials and Mechanics) and Project H43 (Research In Ballistics); and utilizes emerging materials from PE 0602105A (Materials Technology) and applies it to specific Army platforms and the individual Soldier applications.

The work in this PE complements and is fully coordinated with efforts in PE 0602120A (Sensors and Electronic Survivability), PE 0602303A (Missile Technology), PE 0602601A (Combat Vehicle and Automotive Technology), PE 0602624A (Weapons and Munitions Technology), PE 0602705A (Electronics and Electronic Devices), PE 0602716A (Human Factors Engineering Technology), PE 0602786A (Warfighter Technology), PE 0603125A (Combating Terrorism-Technology Development), PE 0603001A (Warfighter Advanced Technology), PE 0603004A (Weapons and Munitions Advanced Technology), PE 0603005A (Combat Vehicle and Automotive Advanced Technology), PE 0603313A (Missile and Rocket Advanced Technology), and PE 0708045A (Manufacturing Technology).

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*

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

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	85.491	0.000	0.000	-	0.000
Current President's Budget	86.737	0.000	0.000	-	0.000
Total Adjustments	1.246	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	2.896	-			
• SBIR/STTR Transfer	-1.650	-			

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2019	FY 2020
Project: HB1: *SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)*		
Congressional Add: *Program Increase - Extended Range Cannon Artillery*	5.000	-
Congressional Add: *Program Increase - Warfighter Protection Technology*	4.998	-
Congressional Add: *FY 2018 NDAA SEC 825 MDAP Cost Overrun*	0.002	-
Congressional Add Subtotals for Project: HB1	10.000	-
Congressional Add Totals for all Projects	10.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H80: *Survivability And Lethality Technology*	-	76.737	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	76.737

Note

In Fiscal Year (FY) 2020 this Project is being realigned with continuity of effort to:
Program Element (PE) 0602141A Lethality Technology
* Project AH5 Projectile and Multi-Function Warhead Technologies
* Project AH6 Disruptive Energetics and Propulsion Technologies
* Project AH7 Lethal and Scalable Effects Technologies
PE 0602143A Soldier Lethality Technology
* Project AZ5 Soldier Protection Technology - Vulnerability
PE 0602145A Next Generation Combat Vehicle Technology
* Project BG6 Advanced Concepts for Active Defense Technology
PE 0602147A Long Range Precision Fires Technology
* Project AH4 Precision and Coop Weapons in a Denied Env Tech

A. Mission Description and Budget Item Justification

This Project investigates, designs and develops materials, methods and models that provide Soldier protection by enhancing survivability and lethality. Specific technology and research thrusts include: lightweight armors and protective structures; crew and component protection from ballistic shock and/or mine-blast; insensitive high energy propellants/munitions to increase lethality and reduce propellant/munitions vulnerability to attack; novel kinetic energy (KE) penetrator concepts to maintain/improve lethality; novel multi-function warhead concepts to enable defeat of a full-spectrum of targets (anti-armor, bunker, helicopter, troops); techniques, methodologies and models to analyze combat effectiveness and identify potential vulnerabilities in current and emerging technologies; and technologies, methods, and analysis tools for injury prediction of vehicle occupants during under-body blast events.

This Project supports efforts in the Army Science and Technology Ground, Lethality, Command, Control, Communications and Intelligence (C3I), and Soldier Portfolios.

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

The Ground Portfolio technology investments are creating a layered vehicle protection suite including Active Protection (Hard-Kill and Soft-Kill) capabilities supported by robust advanced armor.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Disruptive Energetics and Propulsion Technologies	7.902	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort investigates, evaluates, models, and informs the selection of propulsion and energetic materials and technologies to validate novel energetic materials concepts (such as nano-structural and insensitive) that exploit managed energy release required for improving the effectiveness and reducing the vulnerability of future gun/missile systems and warheads. This effort builds on disruptive energetic materials discovery efforts in PE 0601102A (Defense Research Sciences) / Project H43 (Research in Ballistics) to synthesize new materials with energy content up to ten times that of Research Department Explosive.			
Title: Lethal and Scalable Effects Technologies ***Description:*** This effort identifies and models preferred options to reduce energy/mass required to defeat emerging armor threats and to provide multi-purpose capabilities for revolutionary future lethality. In addition, this effort investigates technology options for scaling warhead lethality to enhance urban Warfighting capabilities including control of collateral damage.	6.336	-	-
Title: Survivability/Lethality Analyses ***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.	6.424	-	-
Title: Multi-Threat Armor Formulations and Designs ***Description:*** This effort devises and matures 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. This research is coordinated with PE 0602601A (Combat Vehicle and Automotive Technology) and PE 0603005A (Combat Vehicle and Automotive Advanced Technology).	21.982	-	-
Title: Adaptive and Cooperative Protection Technologies ***Description:*** This effort pursues a holistic approach toward achieving significant weight reduction and defeat of 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 solution to maximize survivability and minimize weight for combat and tactical vehicles.	11.909	-	-
Title: Ballistic and Blast Protection for Dismounted Soldiers ***Description:*** This effort develops unique physics-based models to understand the deflection and stress wave interactions with the human during the complex target interactions between threats and personal protective equipment. Use this knowledge framework to develop low technology readiness level Personal Protective Equipment concepts that are informed by the human effects during impact and blast events.	6.134	-	-
Title: Warrior Injury Assessment Manikin (WIAMan)	3.919	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This work develops an improved demonstrator blast test manikin, data acquisition system, and injury prediction methods and tools that incorporate new medical research and which provides an improved capability to measure and predict skeletal injuries for vehicle occupants during under-body blast events.			
Title: Multi-scale Materials Modeling for Force Protection ***Description:*** This effort develops computational tools for the design of terminal ballistic concepts and material-specific properties to enable novel penetrator-target interactions. Multi-scale materials models developed in previous 6.1 (Basic Research) programs are transitioned to simulation framework suitable for impact and penetration modeling. This approach includes fusing materials and mechanisms to maximize survivability and minimize weight for combat and tactical vehicles.	0.864	-	-
Title: Emerging Overmatch Technologies ***Description:*** This effort supports the development and demonstration of lethality and protection concepts that re-establish overmatch for the next generation of manned and unmanned combat platforms. It will tightly couple scientific research within a campaign of learning to form technology concepts for battlefield domination.	2.194	-	-
Title: Precision and Cooperative Weapons in Denied Environments ***Description:*** The goal of this research is to deliver weapon payloads in more extreme environments (e.g., speed, time, size, survivability, number of agents) against complex, evolving threats (e.g., evading, hiding, counter-measured). Research focuses on understanding and enabling weapons technologies in the areas of vehicle design, control mechanisms, algorithms, embedded processing, and onboard sensing for multi-agent systems with limited, potentially-hostile guidance feedback information.	9.058	-	-
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***Description:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.015	-	-
Accomplishments/Planned Programs Subtotals	76.737	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** HB1 / *SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
HB1: *SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)*	-	10.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	10.000

Note

Congressional increase.

A. Mission Description and Budget Item Justification

These are Congressional Interest Items

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Program Increase - Extended Range Cannon Artillery ***FY 2019 Accomplishments:*** Program Increase - Extended Range Cannon Artillery	5.000	-
Congressional Add: Program Increase - Warfighter Protection Technology ***FY 2019 Accomplishments:*** Program Increase - Warfighter Protection Technology	4.998	-
Congressional Add: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***FY 2019 Accomplishments:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.002	-
Congressional Adds Subtotals	10.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602622A / *Chemical, Smoke and Equipment Defeating Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	4.884	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.884
552: *Smoke/Novel Effect Mun*	-	4.884	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.884

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is realigned with continuity of effort to:
* PE 0602144A (Ground Technology)
* PE 0602145A (Next Generation Combat Vehicle Technology)

A. Mission Description and Budget Item Justification

This PE investigates and evaluates obscurant technologies to increase personnel and platform survivability and develop and validate forensic analysis methods for military and homemade explosive devices, including their precursors and residue. Project 552 (Smoke/Novel Effects Munitions) pursues research in materials science as well as dissemination methodologies, mechanisms, technologies, and techniques to enable forensic analysis of explosive signatures.

Work in this PE is related to, and fully coordinated with, PE 0603004A (Weapons and Munitions Advanced Technology), Project L97 (Smoke and Obscurants Advanced Technology) and PE 0603606A (Landmine Warfare and Barrier Advanced Technology), Project 608 (Countermine & Bar Dev).

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

This work is performed by the United States Army Futures Command

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	5.027	0.000	0.000	-	0.000
Current President's Budget	4.884	0.000	0.000	-	0.000
Total Adjustments	-0.143	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.143	-			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602622A / *Chemical, Smoke and Equipment Defeating Technology*	**Project (Number/Name)** 552 / *Smoke/Novel Effect Mun*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
552: *Smoke/Novel Effect Mun*	-	4.884	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.884

Note

In Fiscal Year (FY) 2020 this Project was realigned to:
Program Element (PE) 0602145A Next Generation Combat Vehicle Technology
* Project BG8 Obscuration Technology
PE 0602144A Ground Technology
* Project BL2 Explosive Forensics Technology

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. Additionally, it researches and investigates forensic analysis technology in explosives and explosives-related chemical signatures, and develops and validates field sampling and forensics methods for use in a forward-deployed laboratory.

This Project sustains Army Science and Technology efforts supporting the Ground Maneuver portfolio.

In FY18/19, work in this Project is related to, and fully coordinated with, PE 0603004A (Weapons and Munitions Advanced Technology) / Project L97 (Smoke and Obscurants Advanced Technology) and PE 0603606A (Landmine Warfare and Barrier Advanced Technology) / Project 608 (Countermine & Bar Dev).

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Advanced Obscurants ***Description:*** This effort investigates new materials and compounds to enable safe, effective screening of personnel and equipment.	1.514	-	-
Title: Obscurant Enabling Technology ***Description:*** This effort investigates distribution technologies for various obscurants.	1.950	-	-
Title: Forensic Analysis of Explosives	1.418	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602622A / *Chemical, Smoke and Equipment Defeating Technology*	**Project (Number/Name)** 552 / *Smoke/Novel Effect Mun*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort investigates forensics analytical methods for military explosives, homemade explosives (HME), HME precursors, and residue analysis for attribution.			
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***Description:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.002	-	-
Accomplishments/Planned Programs Subtotals	4.884	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602623A / *Joint Service Small Arms Program*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	11.890	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	11.890
H21: *Jt Svc Sa Prog (JSSAP)*	-	11.890	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	11.890

Note

In Fiscal Year 2020 (FY20) this Program Element (PE) was realigned with continuity of effort to the following PE:
* PE 0602143A Soldier Lethality Technology

A. Mission Description and Budget Item Justification

This PE investigates individual and crew-served weapon designs and technologies that enhance the fighting capabilities and survivability of the dismounted Warfighter in support of all of the Services. All work is led by the Joint Service Small Arms Program (JSSAP) and is based upon the Joint Service Small Arms Master Plan (JSSAMP) and the Joint Capabilities Integration Development System's Small Arms Analyses.

In FY19 work in this PE is related to, and fully coordinated with, efforts in PE 0601102A (Defense Research Sciences), PE 0602624A (Weapons and Munitions Technology), PE 0603607A (Joint Service Small Arms Program), and PE 0602618A (Ballistic Technology). Beginning in FY20, work in this PE is related to, and fully coordinated with PE 0601102A (Defense Research Sciences), PE 0602143A (Soldier Lethality Technology), and PE 0602141A (Lethality Technology)

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

The work in this PE is performed by the United States Army Futures Command (AFC).

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	12.380	0.000	0.000	-	0.000
Current President's Budget	11.890	0.000	0.000	-	0.000
Total Adjustments	-0.490	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.072	-			
• SBIR/STTR Transfer	-0.418	-			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602623A / *Joint Service Small Arms Program*	**Project (Number/Name)** H21 / *Jt Svc Sa Prog (JSSAP)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H21: *Jt Svc Sa Prog (JSSAP)*	-	11.890	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	11.890

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
Program Element (PE) 0602143A Soldier Lethality Technology
* AY6 Soldier Squad Small Arms Armaments Technology

A. Mission Description and Budget Item Justification

This Project investigates individual and crew-served weapon component design and technologies that enable increased lethality for survivability of the dismounted Warfighter in all the Services. All efforts are based upon the Joint Service Small Arms Master Plan (JSSAMP) and the Joint Capabilities Integration Development System's Small Arms Analyses.

In FY19 work in this Project is related to, and fully coordinated with, efforts in Program Element (PE) 0602624A (Weapons and Munitions Technology) and PE 0603607A (Joint Service Small Arms Program) and PE 0602786A (Warfighter Technology). Beginning in FY20, work in this PE is related to, and fully coordinated with PE 0601102A (Defense Research Sciences), PE 0602143A (Soldier Lethality Technology), and PE 0602141A (Lethality Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Weapon System and Enablers ***Description:*** This effort investigates and evaluates small arms weapon systems and enabling technologies to include: weapon size, weight and power consumption, barrel properties, recoil force, balance, and suitability. This effort also investigates scalable effects weapons in order to increase warfighter capability by providing one cartridge/weapon system delivering variable effects from non-lethal to lethal at greater ranges than currently available.	1.860	-	-
Title: Small Arms Ammunition Research ***Description:*** This effort addresses the design and evaluation of ammunition with reduced weight, signature, fouling and contaminants as well as improved terminal performance and improved performance against soft and hard targets.	9.730	-	-
Title: Small Arms Technology Applied Research	0.300	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602623A / *Joint Service Small Arms Program*	**Project (Number/Name)** H21 / *Jt Svc Sa Prog (JSSAP)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort supports the requirements analysis and the long-term investigation and maturation of technologies to fulfill the Department of Defense small arms capability requirements. The Joint Service Small Arms Program continuously utilizes studies and evaluations to determine the feasibility of novel material concepts; investigate all potential interfaces between the Soldier, training, weapon, optics, and the ammunition; and explore and evaluate interior and exterior ballistic component technologies to enhance weapon performance.			
Accomplishments/Planned Programs Subtotals	11.890	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	379.833	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	379.833
H18: *Weapons & Munitions Technologies*	-	15.291	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	15.291
H1A: *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE (CA)*	-	343.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	343.000
H28: *Warheads/Energetics Technologies*	-	21.542	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	21.542

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is realigned with continuity of effort to the following PEs:
* PE 0602141A Lethality Technology
* PE 0602143A Soldier Lethality Technology
* PE 0602145A Next Generation Combat Vehicle Technology
* PE 0602147A Long Range Precision Fires Technology
* PE 0602148A Future Vertical Lift Technology

A. Mission Description and Budget Item Justification

This PE investigates, designs and evaluates enabling technologies to develop lethal weapons and munitions with increased performance and the potential for lower weight, reduced size, and improved affordability. Project H18 focuses on weapons and munitions development. Project H19 researches technologies to maintain and enhance weapons lethality. Project H28 evaluates munition components such as fuzes, power, warheads with tailorable effects, and munition energetic materials.

Work in this PE is related to, and fully coordinated with, PE 0602303A (Missile Technology), PE 0602105A (Materials Technology), PE 0602618A (Ballistics Technology), PE 0602782A (Command, Control, Communications Technology), and PE 0603004A (Weapons and Munitions Advanced Technology). Beginning in FY20, work in this PE is related to, and fully coordinated with PE 0602147A (Long Range Precision Fires Technology), PE 0602145 (Next Generation Combat Vehicle Technology),PE 0602148 (Future Vertical Lift Technology), PE 0602143A (Soldier Lethality Technology), PE0602141A (Lethality Technology), and PE0602146A (Network C3I Technology).

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

The work in this PE is performed by the United States Army Futures Command (AFC).

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	383.410	0.000	0.000	-	0.000
Current President's Budget	379.833	0.000	0.000	-	0.000
Total Adjustments	-3.577	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-2.525	-			
• SBIR/STTR Transfer	-1.052	-			

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2019	FY 2020
Project: H1A: *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE (CA)*		
Congressional Add: *Program Increase*	25.000	-
Congressional Add: *Extended Range Cannon Artillery*	20.000	-
Congressional Add: *Sensor Fuzed Munition*	20.000	-
Congressional Add: *Laser Weapons Accuracy*	23.000	-
Congressional Add: *Defense Against Small UAS*	30.000	-
Congressional Add: *120 mm Cannon Fired Guided Missile*	50.000	-
Congressional Add: *Weapons Effectiveness in Urban Engagement*	15.000	-
Congressional Add: *Armament Systems Integration*	20.000	-
Congressional Add: *Armament Systems Concepting*	20.000	-
Congressional Add: *Adv Processing of Insensitive Energ Mats*	20.000	-
Congressional Add: *Hybrid Projectile Tech*	10.000	-
Congressional Add: *Composite Barrel Tech*	10.000	-
Congressional Add: *Enhanced Extended Range Artillery System*	65.914	-
Congressional Add: *Novel Printed Armaments Components*	13.000	-
Congressional Add: *FY 2018 NDAA SEC 825 MDAP Cost Overrun*	1.086	-
Congressional Add Subtotals for Project: H1A	343.000	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*

Congressional Add Details ($ in Millions, and Includes General Reductions)

	FY 2019	FY 2020
Congressional Add Totals for all Projects	343.000	-

Change Summary Explanation

Funds reprogrammed out for higher priority Army requirements.

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H18 / *Weapons & Munitions Technologies*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H18: *Weapons & Munitions Technologies*	-	15.291	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	15.291

Note

In Fiscal Year (FY) 2020 this Project will realign to:
Program Element (PE) 0602145A Next Generation Combat Vehicle Technology
* Project BK5 Adv Direct In-Direct Armament Sys (ADIDAS) Tech
PE 0602147A Long Range Precision Fires Technology
* Project AG4 Extended Range Artillery Munition Suite Technology
* Project AG6 Energetic Materials and Advanced Processing Techno
* Project BN5 Fuze and Power for Munitions
PE 0602148A Future Vertical Lift Technology
* Project AK6 Advanced Rotorcraft Armaments Protection System Te

A. Mission Description and Budget Item Justification

This Project designs, investigates, and evaluates component technologies to enable affordable precision munitions as well as provide increased lethality and performance with reduced logistics and advanced direct/indirect fire capabilities for Soldier, ground vehicle and aviation platforms.

Efforts in this Project support the Army Science and Technology Lethality Portfolio.

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

Funds reprogrammed out for higher priority Army requirements.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Novel Propulsion Technology for the Future ***Description:*** This effort explores propellant technologies such as powder coextrusion and grain coatings, while retaining insensitive properties, for employment in gun launch environments as well as directional thrusters including those that deliver a broad spectrum of effects. It also conducts experiments with these propellants to increase the range of artillery and mortar rocket assisted projectiles.	2.849	-	-
Title: Affordable Precision Technologies	2.586	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H18 / *Weapons & Munitions Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort investigates technologies that provide affordable precision capabilities for projectiles fired into Global Positioning System (GPS) denied environments.			
Title: Fuze and Power Technologies for Munitions ***Description:*** This effort investigates and designs innovative fuze and power technologies for enhanced environment and target sensing/classification, warhead initiation schemes and advanced fuze setting to provide enhanced lethality combined effects on targets and advanced initiation schemes for the next generation munitions.	1.029	-	-
Title: Cluster Munitions Replacement Acceleration ***Description:*** This effort will design and develop the critical components that will aid in the maturation of a materiel solution designed to replace 155mm dual purpose improved conventional munition (DPICM) artillery. The components will include the design, development and component testing of fuzing, warhead and stabilization technologies.	1.023	-	-
Title: Programmable Intelligent Collaborative Engagement Munition ***Description:*** This effort develops, matures and integrates a gun hardened suite of components (software, sensors, navigation and communications) that enable the application of distributed, cooperative and collaborative tactics for munitions.	1.463	-	-
Title: Advanced Rotorcraft Armaments Protection System ***Description:*** The Advanced Rotorcraft Armament and Protection System (ARAPS) effort designs and develops Future Vertical Lift (FVL) technologies for lightweight armament systems and multi-role munitions with enhanced lethality at extended ranges. The effort investigates and determines the feasibility of a holistic fire control system that integrates all aspects of offensive and defensive capabilities for advanced protection and enhanced survivability.	1.953	-	-
Title: Radio Frequency Guided Munition ***Description:*** This effort investigates technologies that provide a Radio Frequency (RF) seeking capability for gun-launched projectiles to enable engagement of RF emitting sources and similar targets of interest.	1.463	-	-
Title: ARCHER ***Description:*** This effort designs and develops advanced fire control algorithms and a multirole warhead guided projectile for area defense against medium (Groups 2 and 3) sized unmanned aerial systems (UAS) and aerial rotary wing platforms, point defense against rocket propelled grenades (RPGs), anti-tank guided missiles (ATGMs), and rocket, artillery, and mortars threats as well as precision fires against dismounts in defilade.	2.925	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H18 / *Weapons & Munitions Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Accomplishments/Planned Programs Subtotals	15.291	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H1A / *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE (CA)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H1A: *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE (CA)*	-	343.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	343.000

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Weapons and Munitions Technology applied research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Program Increase ***FY 2019 Accomplishments:*** Program Increase	25.000	-
Congressional Add: Extended Range Cannon Artillery ***FY 2019 Accomplishments:*** Extended Range Cannon Artillery	20.000	-
Congressional Add: Sensor Fuzed Munition ***FY 2019 Accomplishments:*** Sensor Fuzed Munition	20.000	-
Congressional Add: Laser Weapons Accuracy ***FY 2019 Accomplishments:*** Laser Weapons Accuracy	23.000	-
Congressional Add: Defense Against Small UAS ***FY 2019 Accomplishments:*** Defense Against Small UAS	30.000	-
Congressional Add: 120 mm Cannon Fired Guided Missile ***FY 2019 Accomplishments:*** 120 mm Cannon Fired Guided Missile	50.000	-
Congressional Add: Weapons Effectiveness in Urban Engagement ***FY 2019 Accomplishments:*** Weapons Effectiveness in Urban Engagement	15.000	-
Congressional Add: Armament Systems Integration ***FY 2019 Accomplishments:*** Armament Systems Integration	20.000	-
Congressional Add: Armament Systems Concepting	20.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H1A / *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE (CA)*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2019**	**FY 2020**
FY 2019 Accomplishments: Armament Systems Concepting		
Congressional Add: Adv Processing of Insensitive Energ Mats ***FY 2019 Accomplishments:*** Adv Processing of Insensitive Energ Mats	20.000	-
Congressional Add: Hybrid Projectile Tech ***FY 2019 Accomplishments:*** Hybrid Projectile Tech	10.000	-
Congressional Add: Composite Barrel Tech ***FY 2019 Accomplishments:*** Composite Barrel Tech	10.000	-
Congressional Add: Enhanced Extended Range Artillery System ***FY 2019 Accomplishments:*** Enhanced Extended Range Artillery System	65.914	-
Congressional Add: Novel Printed Armaments Components ***FY 2019 Accomplishments:*** Novel Printed Armaments Components	13.000	-
Congressional Add: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***FY 2019 Accomplishments:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	1.086	-
Congressional Adds Subtotals	343.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H28 / *Warheads/Energetics Technologies*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H28: *Warheads/Energetics Technologies*	-	21.542	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	21.542

Note

In Fiscal Year (FY) 2020 this Project was realigned to:
Program Element (PE) 0602141A Lethality Technology
* Project AH9 Advanced Warheads Technology
PE 0602147A Long Range Precision Fires Technology
* Project AG6 Energetic Materials and Advanced Processing Techno
* Project AG8 Advanced Energetics Technology
PE 0602148A Future Vertical Lift Technology
* Project AK2 Aviation Survivability Technology

A. Mission Description and Budget Item Justification

This Project investigates and designs enabling warhead and energetic technologies such as new propellant techniques, and high-density explosives to produce smaller, lighter, more effective, multi-role warheads, flare and pyrotechnic countermeasures, and novel approaches for ammunition demilitarization and combat in complex environments.

Efforts in this Project support the Army Science and Technology Lethality Portfolio.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Scalable Warhead Technology ***Description:*** This effort designs scalable and adaptive explosives and reactive materials technology for either gun or missile-launched weapons and munitions that can deliver a broad spectrum of effects with reduced collateral damage. In addition, this effort will facilitate the design and development of improved area clearance technologies.	5.830	-	-
Title: Advanced Energetics ***Description:*** This effort develops advanced energetic materials and novel processing techniques for future explosives and propulsion applications that enable an increase in range, lethality, and utility of ammunitions.	8.074	-	-
Title: Tunable Pyrotechnics	3.615	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H28 / *Warheads/Energetics Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort develops smoke and flare countermeasure for passive protection for ground and air combat platforms, and hand held signals for illumination and signaling. These capabilities will increase warfighter and aircraft survivability.			
Title: Advanced Warheads ***Description:*** This effort explores multiple pathways to enhance lethal efforts for future warheads against emerging peer/near peer target sets. Investigates synergistic effects of novel micro warheads using advance materials.	4.023	-	-
Accomplishments/Planned Programs Subtotals	21.542	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	98.855	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	98.855
EM4: *Electric Component Technologies (CA)*	-	38.500	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	38.500
EM8: *High Power And Energy Component Technology*	-	12.284	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	12.284
H11: *Tactical And Component Power Technology*	-	10.490	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	10.490
H94: *Elec & Electronic Dev*	-	37.581	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	37.581

Note

In Fiscal Year (FY) 2020 this Program Element (PE) is realigned, with continuity of effort realigned to the following PEs:
* PE 0602143A Soldier Lethality Technology
* PE 0602144A Ground Technology
* PE 0602145A Next Generation Combat Vehicle Technology
* PE 0602146A Network C3I Technology
* PE 0602148A Future Vertical Lift Technology
* PE 0602150A Air and Missile Defense Technology

A. Mission Description and Budget Item Justification

This PE designs and evaluates power components and power management technologies, frequency control and timing devices, high power microwave devices, display technologies, and electronic components. The applied research on these technologies enable the ability to perform precision deep fires against critical mobile and fixed targets; investigate all-weather, day or night, theater air defense against advanced enemy missiles and aircraft; as well as investigate enhanced communications and target acquisition through support of capabilities such as autonomous missile systems, advanced land combat vehicles, smart anti-tank munitions, electric weapons, secure jam-resistant communications, automatic target recognition, foliage-penetrating radar, and combat identification. Project EM8 designs and evaluates high-power electronic components and technologies. Project H11 designs, investigates and validates advanced power and energy technologies (batteries, alternative energy and hybrids) and power management and distribution techniques (wireless power, intelligent power management). Project H17 designs and evaluates flexible displays in conjunction with the Flexible Display Center. Project H94 researches and evaluates electronic component technologies such as photonics, micro electromechanical systems, imaging laser radar, magnetic materials, ferroelectrics, microwave and millimeter-wave components, and electromechanical systems.

Work in this PE complements and is fully coordinated with efforts in PE 0602120A (Sensors and Electronic Survivability), PE 0602307A (Advanced Weapons Technology), PE 0602709A (Night Vision Technology), PE 0602782A (Command, Control, Communications Technology), PE 0602783A (Computer and Software

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*

Technology), PE 0603001A (Warfighter Advanced Technology), PE 0603004A (Weapons and Munitions Advanced Technology), and PE 0603772A (Advanced Tactical Computer Science and Sensor Technology).

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

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

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

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	96.760	0.000	0.000	-	0.000
Current President's Budget	98.855	0.000	0.000	-	0.000
Total Adjustments	2.095	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	2.937	-			
• SBIR/STTR Transfer	-0.842	-			

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2019	FY 2020
Project: EM4: *Electric Component Technologies (CA)*		
Congressional Add: *Flexible Hybrid Electronics Tech*	5.000	-
Congressional Add: *Silicon Carbide Electronics Research*	19.982	-
Congressional Add: *Position Navigation Timing Systems*	8.500	-
Congressional Add: *Tactical Power Generation and Storage Systems*	5.000	-
Congressional Add: *FY 2018 NDAA SEC 825 MDAP Cost Overrun*	0.018	-
Congressional Add Subtotals for Project: EM4	38.500	-
Congressional Add Totals for all Projects	38.500	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** EM4 / *Electric Component Technologies (CA)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
EM4: *Electric Component Technologies (CA)*	-	38.500	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	38.500

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Electronics and Electronic Component applied research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Flexible Hybrid Electronics Tech ***FY 2019 Accomplishments:*** Flexible Hybrid Electronics Tech	5.000	-
Congressional Add: Silicon Carbide Electronics Research ***FY 2019 Accomplishments:*** Silicon Carbide Electronics Research	19.982	-
Congressional Add: Position Navigation Timing Systems ***FY 2019 Accomplishments:*** Position Navigation Timing Systems	8.500	-
Congressional Add: Tactical Power Generation and Storage Systems ***FY 2019 Accomplishments:*** Tactical Power Generation and Storage Systems	5.000	-
Congressional Add: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***FY 2019 Accomplishments:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.018	-
Congressional Adds Subtotals	38.500	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** EM8 / *High Power And Energy Component Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
EM8: *High Power And Energy Component Technology*	-	12.284	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	12.284

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
Program Element (PE) 0602145A Next Generation Combat Vehicle
* Project BF8 Artificial Intelligence & Machine Learning Tech
* Project BH7 Enhanced VETRONICS Technology
PE 0602146A Network C3I Technology
* Project AO2 Stand-In Advanced RF Effects (STARE)
* Project AP4 CEMA Camouflage Technology
* Project AP5 Electronics Warfare Technology
PE 0602150A Air and Missile Defense Technology
* Project AD2 High Energy Laser (HEL) Enabling and Support Tech

A. Mission Description and Budget Item Justification

This Project provides for the research, development, and evaluation of high-power electronic components, materials, and related technologies. These technologies have application in compact and efficient power conversion, conditioning, and management sub-systems; energy storage and conversion devices; radio frequency (RF)/ microwave and solid-state laser directed energy weapons (DEW); traditional and non-traditional RF and laser electronic attack; and RF photonics. All project elements are coordinated with, and as appropriate leveraged by, DEW and power/energy programs in the Air Force, Navy, High Energy Laser Joint Technology Office, Defense Threat Reduction Agency, national labs, university consortia, and relevant industry and foreign partners. The products of this research are required by developers of Army and Department of Defense (DoD) systems to evolve traditional (mechanical-based) sub-systems such as geared transmissions, plate armor, and kinetic projectiles to electrically-based ones. These products will provide the Soldier enhanced survivability and lethality through increased power management and energy savings as well as new fighting capabilities offered only by electrical power.

This Project sustains Army science and technology efforts supporting the Ground Maneuver, Lethality, Soldier and Command, Control, Communications and Intelligence Portfolios.

The work in this Project is coordinated with the Army Combat Capabilities Development Command, Ground Vehicle Systems Center, Armaments Center, Aviation and Missile Center, and Command, Control, Computers, Cyber, Intelligence, Surveillance, and Reconnaissance Center and the United States Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT).

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

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** EM8 / *High Power And Energy Component Technology*

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Advanced Solid-State Laser Technology and Integrated Photonic Technologies ***Description:*** Research novel solid-state laser concepts, architectures, and components with the goal of providing advanced laser technology to Army directed energy weapon and tactical laser developers. Exploit breakthroughs in laser technology, develop and employ innovative laser gain material, and utilize photonics to meet the stringent weight/volume requirements for Army platforms, especially to enhance and improve the generation, transmission, reception, and processing of RF signals. Applied laser research will be conducted in close collaboration with domestic and foreign material vendors, university researchers, and major laser diode manufacturers	2.000	-	-
Title: Electronic Attack Technologies/Spectrum Sensing and Exploitation ***Description:*** This effort investigates emerging technologies related to electronic warfare (EW) applications, non-kinetic survivability/lethality, and emerging concepts of operation, such as cognitive radar, in the increasingly contested and congested electromagnetic environment, with the goal of enhancing the survivability/lethality of Army platforms through electronic attack (EA), electronic warfare support (ES), and electronic protection (EP).	1.788	-	-
Title: Electronic Components and Materials Research ***Description:*** Investigate compact, high-efficiency, high-temperature, and high-power component technologies (e.g., semiconductor, magnetic, and dielectric devices) for hybrid-electric propulsion, electric power generation and conversion, and smart micro-grid power distribution. Research addresses current and future Army-unique performance and operational requirements.	3.090	-	-
Title: Advanced Distributed Power for Autonomous Plaforms ***Description:*** The effort investigates power distribution and conversion technologies to provide compact, efficient, and high power capabilities for electrical and electro-mechanical loads supporting both mobile and stationary platforms. High voltage and intelligent control methods will be coupled with the ongoing research in autonomy technologies to provide advanced performance enhancements in mobility and capabilities for these platforms. Research on innovative electric machines covering both electrical generation and motor technologies will focus on providing efficient, power dense, fault tolerant generation and mobility capabilities. Research addresses current and future Army-unique power delivery challenges in compact autonomous air and ground platforms.	1.400	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** EM8 / *High Power And Energy Component Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: RF Electronic Attack/Surveillance (Grey C3) ***Description:*** Investigate emerging technologies to enable EW applications in a grey environment. The goal is to develop software and reconfigurable RF hardware in a handheld form factor for distributed electronic attack, distributed EW support, and communications. EW support includes advanced passive and active RF sensing.	2.000	-	-
Title: Vulnerability Analysis Methodology for CEMA threats ***Description:*** Research and investigate the optimum configuration of experimental and analysis methodology for separate and combined cyber and electromagnetic threat attack so as to better support and inform Army system designers, analysts, evaluators, and decision makers.	2.000	-	-
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***Description:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.006	-	-
Accomplishments/Planned Programs Subtotals	12.284	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H11 / *Tactical And Component Power Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H11: *Tactical And Component Power Technology*	-	10.490	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	10.490

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
Program Element (PE) 0602143A Soldier Lethality Technology
* Project BD8 Soldier & SM Unit Tactical Energy Tech
PE 0602148A Future Vertical Lift Technology
* Project AM4 Opt Energy Stg & Therm Mgmt for FVL Survivability

A. Mission Description and Budget Item Justification

This Project identifies, advances, and enhances emerging power generation, energy storage, and power management components and software. This Project researches advancements in enabling power management, rapid decision making, expeditionary maneuver, and distributed operations across the battlefield. This Project also researches materials and components to develop lightweight, higher capacity, safer and more efficient power technologies that will enable continuous and energy aware operations while on the move and across battlefield environments.

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Tactical Power Generation Technology ***Description:*** This effort designs, investigates and validates Soldier-borne power generation and energy storage technologies in order to decrease Soldier load and power burden, and increase power capabilities by providing more energy to prolong mission run-time. This effort will investigate energy harvesting devices while on the move which will enable a continuous operations and reduced logistics for the Soldier. This effort will also investigate advanced hybrid battery chemistries for wearable, flexible battery designs.	5.843	-	-
Title: Optimized Energy for C4ISR Platforms ***Description:*** This effort investigates power and thermal management associated with high power Command, Control, Communications, computers, Intelligence, Surveillance and Reconnaissance (C4ISR) capabilities on ground and air platforms	4.642	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H11 / *Tactical And Component Power Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
enabling enhanced mobility and mission flexibility. This effort funds research to improve platform efficiency through the use of on-demand hybrid power architectures, while also researching ways to eliminate platform thermal constraints. This effort will also investigate very high density power sources and energy storage for high rate pulsed power, power management and thermal management for dynamic high rate pulsed power.			
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***Description:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.005	-	-
Accomplishments/Planned Programs Subtotals	10.490	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H94 / *Elec & Electronic Dev*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H94: *Elec & Electronic Dev*	-	37.581	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	37.581

Note

In Fiscal Year (FY) 2020 this Project is realigned to:
Program Element (PE) 0602143A Soldier Lethality Technology
* Project BD8 Soldier & Sm Unit Tactical Energy Tech
PE 0602144A Ground Technology
* Project BL1 Materials and Manufacturing Research Technology
PE 0602145A Next Generation Combat Vehicle
* Project BI2 Sensor Protection Technology
* Project BJ3 Hydrogen Based Combat System Technology
PE 0602146A Network C3I Technology
* Project AO4 Energy Efficient Devices Technology
* Project AV5 Protective Technologies
* Project AV9 Advanced PNT for GPS Independent Environments Tech
PE 0602148A Future Vertical Lift Technology
* Project AK2 Aviation Survivability Technology
* Project AL8 Holistic Situational Awareness and Dec Making Tech
PE 0602150A Air and Missile Defense Technology
* Project AD5 Next Generation Fires Radar Technology

A. Mission Description and Budget Item Justification

This Project designs and characterizes electronics, electronic components, and electronic devices for Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) applications and battlefield power and energy applications. Significant areas of component research relevant to C4ISR include: antennas, millimeter wave components and imaging, micro- and nano-technology, eye-safe laser radar (LADAR), vision and sensor protection, infrared (IR) imaging, photonics, and prognostics and diagnostics. Areas of research relevant to power and energy include power and thermal management, micro-power generators and advanced batteries, fuel reformers, fuel cells for hybrid power sources, and photosynthetic routes to fuel and electricity.

This Project supports Army science and technology efforts in the Command, Control, Communications and Intelligence, Soldier, Ground and Air portfolios. Work in this Project is fully coordinated with PE 0602709A (Night Vision Technology), PE 0603001A (Warfighter Advanced Technology), PE 0603004A (Weapons and Munitions Advanced Technology), PE 0603005A (Combat Vehicle and Automotive Advanced Technology), and PE 0603313A (Missile and Rocket Advanced Technology).

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

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H94 / *Elec & Electronic Dev*

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Antennas, Microwave Components, and Millimeter Wave Imaging ***Description:*** This effort designs, characterizes, and validates high performance antennas, microwave components, and software for multifunction radar, radio frequency (RF) sensing, and communication systems. Research areas include scanning techniques, broadbanding, beamforming, polarization, platform integration, and affordability. For microwave components, research areas include software defined radios, analog-to-digital conversion rates, bandwidth resolution, bit accuracy, circuit design and affordability.	5.664	-	-
Title: Survivability for Wireless Tactical Networks ***Description:*** This effort researches, designs and implements protocols and algorithms for networks of physical devices and autonomous systems operating under severe energy and bandwidth constraints, and which are vulnerable to adversarial infiltration. The objective is to enhance the performance and survivability of these tactical wireless networks through improved monitoring and detection of network problems, resulting from both adversarial activity and the operating environment, and through proactive adaption of the computer and network routers to these dynamics.	0.750	-	-
Title: Sensor Protection ***Description:*** This effort develops and characterizes materials for protection of electro-optic (EO) systems from lasers.	4.625	-	-
Title: Applied Photonic and Optoelectronic Devices ***Description:*** This effort models and develops materials and devices for the next generation Army sensor systems. Semiconductor materials and devices from Ultraviolet (UV) to Infrared (IR) with active and passive imaging capabilities will be modeled and developed. This will allow the Soldier to maintain situational awareness day and night under cluttered battlefield conditions. Sources and detectors for next generation secure battlefield communication devices will also be developed. For asymmetric threats, chemical sensing devices will also be studied and developed.	2.141	-	-
Title: Power and Thermal Management for Small Systems ***Description:*** This effort investigates, designs, and fabricates micro-electromechanical system (MEMS)-based components to improve power generation and micro-cooling technology for both dismounted Soldier and future force applications.	0.903	-	-
Title: Power and Energy	1.671	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H94 / *Elec & Electronic Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This research focuses on the design and characterization of chemistries, materials, and components for advanced batteries, fuel reformers, and fuel cells. Potential Army applications include hybrid power sources, smart munitions, hybrid electric vehicles, and Soldier power applications. Additionally, investigate the applicability of photosynthesis to provide fuel and electricity for Soldier power applications, and investigate silicon carbide (SiC) power module components that could enable compact, high efficiency, high temperature, and high power density converters for motor drive and pulse power applications.			
Title: Energy Harvesting ***Description:*** This research develops technologies to substantially reduce the number of batteries required to accomplish dismounted Soldier/Squad mission objectives, thereby significantly reducing Soldier-borne load and logistics requirements. Research will explore technologies to harvest electrical power by converting and storing energy via engineered structures and electronic bandgaps, MEMS-based micro-scale power conversion, and heterogeneous three dimension (3D) assembly of MEMS with other devices to enable efficient, distributed power conversion. Research explores novel paths to local fuel and energy production, including artificial photosynthesis, to extract hydrogen and electricity directly from water and sunlight.	3.022	-	-
Title: Energy Efficient Electronics & Photonics ***Description:*** This effort addresses sustainment operations by unburdening the Soldier and reducing logistics requirements (e.g., fewer batteries) for communications, computing, and sensing. The objective is to improve the underlying energy efficiency of supply and demand for Soldier-portable and unattended sensor electronics to enable the dismounted Soldier to maintain communications, freedom of movement, and increase mission duration. The majority of the electronics power used by the dismounted Soldier and by unattended sensors is attributable to RF communications. In addition, freedom of movement and action during sustained and high tempo operations requires seamless battery recharging. To address these challenges, energy efficient electronics research includes RF circuits, devices, materials and wireless power distribution. Energy efficiency improvements will be developed and investigated in support of five key sensor and electronic areas: RF component devices, passively powered components, low-power, long-lived sources, wireless power transfer, and advanced battery chemistries. Additionally, materials and devices used for photonic applications, such as laser diodes and fiber lasers, will be studied and improved with an emphasis on overall size, weight, and power consumption efficiency gains.	5.513	-	-
Title: Precision Measurement Technology for Contested Environments ***Description:*** This research focuses on technologies that will enable precise and assured position, navigation and timing in global positioning system (GPS)-denied environments. The first objective of this research is to improve the size, weight, power, cost, and accuracy of current micro-Inertial Measurement Systems (IMS) through the design, and fabrication of MEMS gyroscopes. The second objective is to develop an opto-electronic device that can be used as an ultra-precise local oscillator with improved stability for precision timing applications. The third objective is to address the ability to transmit jam-resistant precision timing	2.983	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H94 / *Elec & Electronic Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
signals by investigating the transmission of precision, synchronized timing signals over optical fibers and free-space using lasers. The fourth objective is to explore new RF antenna concepts to extend the reach of IMS systems through pseudolites (ground-based substitutes for GPS satellites) and Soldier-borne systems, and to integrate multiple sensor modalities with the IMSs using sensor fusion techniques to reduce drift and increase positional accuracy.			
Title: Anti-Tamper (AT) Technology Development ***Description:*** This effort develops tools, devices, and techniques to protect acquisition program systems and Critical Program Information (CPI) from adversarial threats. This work is executed by the Army Anti-Tamper Office located at the Aviation and Missile Research, Development and Engineering Center (AMRDEC) at Redstone Arsenal, AL.	5.900	-	-
Title: Technologies for Alternative Energy ***Description:*** Design and develop novel concepts of energy generation, energy capture materials, and component technologies for efficient conversion of ambient energy to electrical energy for use and storage. Design components to include microscale power devices for multimodal harvesting and efficient distributed power conversion.	1.191	-	-
Title: Quantum for Assured PNT in Zero-GPS Environments Acceleration ***Description:*** To develop quantum-based GPS-independent ultra-high precision PNT in a contested/gps denied battlespace for mission durations up to 7 days w/o external timing or position re-synchronization. This effort also enables Camouflage, Concealment, and Decoys (CC&D) in an Electronic Warfare (EW) space and synchronization of disaggregated platforms / fires across the battlefield for distributed sensing, processing, and lethal effect.	3.201	-	-
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***Description:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.017	-	-
Accomplishments/Planned Programs Subtotals	37.581	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	33.218	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	33.218
H95: *Night Vision And Electro-Optic Technology*	-	29.218	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	29.218
K90: *NIGHT VISION COMPONENT TECHNOLOGY (CA)*	-	4.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.000

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is realigned with continuity of effort to the following PEs:
* PE 0602143A Soldier Lethality Technology
* PE 0602145A Next Generation Combat Vehicle Technology
* PE 0602148A Future Vertical Lift Technology

A. Mission Description and Budget Item Justification

This PE conducts applied research and investigates core night vision and electronic sensor components and software to improve the Army's capability to operate in all battlefield conditions. Technologies pursued in this PE have the potential to provide the Army with new, or enhanced, capabilities to detect and identify targets farther on the battlefield, operate in obscured conditions, maintain a higher degree of situational understanding (SU), and operate autonomously. Project H95 advances infrared (IR) sensor technologies, investigates sensor materials, designs advanced multi-function lasers for marking, targeting, designation, wind-sensing, and range finding, and develops models and simulations for validating advanced sensor technologies. Project K90 funds Congressional special interest items.

Work in this PE is fully coordinated with PE 0602120A (Sensors and Electronic Survivability), PE 0602705A (Electronics and Electronic Devices), PE 0602712A (Countermine Technology), PE 0603606A (Landmine Warfare and Barrier Advanced Technology), PE 0603710A (Night Vision Advanced Technology), and PE 0708045A (End Item Industrial Preparedness Activities).

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

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

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	**Date:** February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*

B. Program Change Summary ($ in Millions)	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**
Previous President's Budget	33.573	0.000	0.000	-	0.000
Current President's Budget	33.218	0.000	0.000	-	0.000
Total Adjustments	-0.355	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.355	-			

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2019**	**FY 2020**
Project: K90: *NIGHT VISION COMPONENT TECHNOLOGY (CA)*		
Congressional Add: *Night Vision Component Technology*	4.000	-
Congressional Add Subtotals for Project: K90	4.000	-
Congressional Add Totals for all Projects	4.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*	**Project (Number/Name)** H95 / *Night Vision And Electro-Optic Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H95: *Night Vision And Electro-Optic Technology*	-	29.218	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	29.218

Note

In Fiscal Year (FY) 2020 this Project is realigned to:
Program Element (PE) 0602143A Soldier Lethality Technology
* Project BD1 Adv Soldier Sensors/Displays Tech for Dismounts
PE 0602145A Next Generation Combat Vehicle Technology
* Project BF9 Sensors for Autonomous Operations and Surv Tech
* Project BJ2 Tactical and Navigation Lasers Sensors Technology
* Project BH2 C4ISR Modular Autonomy Technology
PE 0602148A Future Vertical Lift Technology
* Project AK2 Aviation Survivability Technology

A. Mission Description and Budget Item Justification

This Project conducts applied research and develops component technologies that enable improved Reconnaissance, Surveillance, Target Acquisition (RSTA), and situational understanding (SU). Technologies include novel focal plane arrays (FPAs), lasers, and electronics. It also includes modeling and simulation to predict performance and to determine operational effectiveness of these technologies. Research focuses on infrared (IR) FPAs necessary to search, identify and track targets in all day/night visibility and battlefield conditions and to improve standoff detection in all operational environments. This Project designs, fabricates, and validates large format IR FPAs for sensors to simultaneously provide wide area viewing and the high resolution imagery for situational understanding, persistent surveillance, and hostile fire detection. This Project investigates and designs novel sensor electronics such as Digital Read Out Integrated Circuits (DROICs) to enable multifunction sensing. This Project also investigates and matures new semiconductor materials formed by a combination of elements from the periodic table. In addition, this Project develops algorithms for enhanced IR functionality, which provides the ability to perform detection and identification at extended ranges, as well as the ability to detect deeply buried targets. The reduction of size, weight and power - Cost (SWaP-C) is a key research objective for all efforts.

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Sensor Modeling and Simulation Technology	4.769	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*	**Project (Number/Name)** H95 / *Night Vision And Electro-Optic Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort investigates, verifies, and validates sensor engineering models, measurement techniques, and simulations. The goal is to improve the fidelity and adaptability of modeling and simulation capabilities for Warfighter training, sensor system analysis, and identification and assessment of phenomenology associated with imaging technologies and the calibration of imaging technologies.			
Title: Advanced Multifunction Laser Technology ***Description:*** This effort investigates technologies for a new class of multi-wavelength laser modules which will have the ability to replace multiple laser targeting systems and reduce the size, weight, and power (SWaP) of current devices. The goal is to achieve a single housing, electronics board, power supply, and telescope for all applications to provide a reduction in the SWaP of multi-function laser systems. The objective is to develop a laser with higher efficiency and lower volume than existing pulsed Mid-wave Infrared (MWIR) and Long-wave Infrared (LWIR) lasers, which will be used for threat sensor detection and active imaging in degraded visual environments.	5.128	-	-
Title: Multi-Function Digital Readout Integrated Circuits for Cooled and Uncooled Focal Plane Arrays ***Description:*** The objective of this effort is the development of advanced two-Dimensional (2D) and three-Dimensional (3D) DROICs to replace legacy 2D analog ROICs. This effort will investigate and design a digital readout architecture optimized for large format, high resolution IR FPAs through the use of modeling, analysis, and simulations. This enabling technology will bring substantial advancements to IR imaging capabilities.	7.356	-	-
Title: Computational Imaging ***Description:*** This effort develops component technology designed to increase battle space awareness, threat detection, and target identification (ID) by using a methodology of computation algorithms and optics combined with display and vision processing. The objective is to provide extended range, multi-spectral imaging capability, with reductions to the size, weight and cost (SWaC), for the individual warfighter. This effort will leverage work accomplished under Multi-Function DROICs for Cooled and Uncooled FPAs to provide improved mounted and dismounted Soldier situational understanding in urban and complex terrain under low light and visibility conditions.	2.182	-	-
Title: High Sensitivity High Speed Uncooled Longwave Infrared (UCIR) Technology ***Description:*** This effort develops a new class of uncooled high sensitivity/high speed IR imaging sensors to enable applications such as Hostile Fire Indication (HFI), Improvised Explosive Device (IED) and disturbed earth detection, driving/ pilotage guidance, and 360 situational awareness on all platforms.	5.071	-	-
Title: Embedded Processing for Autonomous Sensors	4.712	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*	**Project (Number/Name)** H95 / *Night Vision And Electro-Optic Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort develops signal and image processing algorithms at the sensor to provide actionable information in contextually relevant manner to the decision maker.			
Accomplishments/Planned Programs Subtotals	29.218	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*	**Project (Number/Name)** K90 / *NIGHT VISION COMPONENT TECHNOLOGY (CA)*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
K90: *NIGHT VISION COMPONENT TECHNOLOGY (CA)*	-	4.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.000

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Night Vision Component Technology applied research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Night Vision Component Technology	4.000	-
FY 2019 Accomplishments: Night Vision Component Technology		
Congressional Adds Subtotals	4.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602712A / *Countermine Systems*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	26.594	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	26.594
H24: *Countermine Tech*	-	14.803	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	14.803
H35: *Camouflage & Counter-Recon Tech*	-	5.791	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.791
HB2: *COUNTERMINE COMPONENT TECHNOLOGY (CA)*	-	6.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	6.000

Note

In Fiscal Year (FY) 2020 this Program Element (PE) is realigned with continuity of effort to the following:
* PE 0602143A (Soldier Lethality Technology)
* PE 0602144A (Ground Technology)
* PE 0602145A (Next Generation Combat Vehicle Technology)

A. Mission Description and Budget Item Justification

This PE investigates, designs, and develops technologies to improve counter explosive hazard detection, signature management, and counter- sensor capabilities. Focus areas are sensor components, sub-components, and software algorithms to improve detection of mines and explosive threats; novel methods to defeat mines and explosive threats; and signature management technologies to reduce the reconnaissance capabilities of enemy forces. The technologies being investigated are for both mounted and dismounted applications. Project H24 (Countermine Technology) investigates state of the art counter explosive hazard technologies to accurately detect and neutralize threats with a high probability, reduce false alarms, and enable an increased operational tempo. Project H35 (Camouflage and Counter-Recon Tech) designs and develops advanced sensor protection, signature management, and deception techniques for masking friendly force capabilities and intentions.

Work in this PE is related to and fully coordinated with PE 0602120A (Sensors and Electronic Survivability), PE 0602622A (Chemical, Smoke and Equipment Defeating Technology), PE 0602624A (Weapons and Munitions Technology), PE 0602709A (Night Vision Technology), PE 0602784A (Military Engineering Technology), PE 0603004A (Weapons and Munitions Advanced Technology), PE 0603606A (Landmine Warfare and Barrier Advanced Technology), and PE 0603710A (Night Vision Advanced Technology).

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

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602712A / *Countermine Systems*

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	27.223	0.000	0.000	-	0.000
Current President's Budget	26.594	0.000	0.000	-	0.000
Total Adjustments	-0.629	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.629	-			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602712A / *Countermine Systems*	**Project (Number/Name)** H24 / *Countermine Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H24: *Countermine Tech*	-	14.803	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	14.803

Note

In Fiscal Year (FY) 2020 this Project will realign to:
Program Element (PE) 0602144A Ground Technology
* Project BL4 Countermine Technology)
PE 060145A Next Generation Combat Vehicle Technology
* Project BJ7 Detection of Explosive Hazards Technology

A. Mission Description and Budget Item Justification

This Project investigates, designs, and develops new technology components, sub-components, and software algorithms for detection, discrimination, and neutralization of individual mines, minefields, and other explosive threats. The goals of this Project are to accurately detect threats with a high probability, reduce false alarms, and enable an increased operational tempo.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Standoff Sensors for Explosive Hazard Detection ***Description:*** This effort addresses the challenges of sensing and confirming potential in-road and roadside threats at standoff ranges. The effort focuses on understanding the phenomenologies that impact sensor design concepts and steer novel technologies that provide the primary means for detecting anomalies. The result is higher-confidence target detection and improved clutter/background filtering. Examples of candidate technologies include Forward Looking (FL) Electro-Optic/Infrared (EO/IR) and Ground Penetrating Radar (GPR) sensors, which are used to detect surface threats.	10.896	-	-
Title: Neutralization and Breaching Technology ***Description:*** This effort addresses the challenges of selectively neutralizing individual explosive hazards at standoff ranges as well as the challenges of scaling up such capabilities to neutralize multiple explosive hazards for effective complex obstacle breaches. This effort focuses on validation of techniques to confirm the location of buried threats and on the design and development of technology components to defeat the confirmed target. The result is matured components to facilitate follow-on efforts to develop an integrated explosive hazard neutralization and breaching capability. Examples of candidate technologies for neutralization include high energy devices (lasers and radio frequency) and explosives.	3.900	-	-
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.007	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602712A / *Countermine Systems*	**Project (Number/Name)** H24 / *Countermine Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: FY 2018 NDAA SEC 825 MDAP Cost Overrun			
Accomplishments/Planned Programs Subtotals	14.803	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602712A / *Countermine Systems*	**Project (Number/Name)** H35 / *Camouflage & Counter-Recon Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H35: *Camouflage & Counter-Recon Tech*	-	5.791	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.791

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
Program Element (PE) 0602145A Next Generation Combat Vehicle Technology
* Project BI2 Sensor Protection Technology

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 camouflage coatings and paints. Novel technologies are investigated, such as 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 Science and Technology priority focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Camouflage and Counter-Reconnaissance Technology for Advanced Spectral Sensors ***Description:*** This effort investigates and advances new techniques to reduce susceptibility of sensors to detection by lasers, Electro-Optic (EO) sensor systems, and Infrared (IR) sensor systems. This effort also researches signature reduction approaches for camouflage nets.	5.791	-	-
Accomplishments/Planned Programs Subtotals	5.791	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602712A / *Countermine Systems*	**Project (Number/Name)** HB2 / *COUNTERMINE COMPONENT TECHNOLOGY (CA)*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
HB2: *COUNTERMINE COMPONENT TECHNOLOGY (CA)*	-	6.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	6.000

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Countermine Systems applied research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Program Increase - Developing and Improving Counter-IED Sensors (CCDC) ***Description:*** Congressional increase.	3.100	-	-
Title: Program Increase - Development of Soil Parameters (USACE)	2.900	-	-
Accomplishments/Planned Programs Subtotals	6.000	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	23.755	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	23.755
H70: *Human Fact Eng Sys Dev*	-	23.755	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	23.755

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is realigned with continuity of effort to the following PEs:
* PE 0602143A Soldier Lethality Technology
* PE 0602145A Next Generation Combat Vehicle Technology

A. Mission Description and Budget Item Justification

This PE conducts applied research on human factors to maximize the effectiveness of Soldiers in concert with their equipment. The resulting data are the basis for weapon systems and equipment design standards, guidelines, handbooks, and Soldier training as well as manpower requirements to improve equipment operation and maintenance. Application of this research will yield reduced workload, fewer errors, enhanced Soldier protection, user acceptance, and allows the Soldier to extract the maximum performance from the equipment.

Major efforts research sources of stress, potential stress moderators, and intervention methods, and identify and quantify human performance measures and methods to address current and future warrior performance issues. Individual efforts exploit adaptive learning methods and strategies, enhance and validate human performance modeling tools; investigate integration of advanced concepts in crew stations designs, optimizes interfaces for information systems and improves human robot interaction (HRI) in a full mission context.

Results of these efforts are transitioned to the Research, Development, and Engineering Centers, the Program Executive Offices (PEO) & Program Managers, Army Training and Doctrine Command (TRADOC), Army Medical Command (MEDCOM), Human Systems Integration (HSI) Directorate (Army G1), and Army Test and Evaluation Command (ATEC).

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

Work in this PE is performed by the United States Army Futures Command (AFC).

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	24.121	0.000	0.000	-	0.000
Current President's Budget	23.755	0.000	0.000	-	0.000
Total Adjustments	-0.366	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.007	-			
• SBIR/STTR Transfer	-0.359	-			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*	**Project (Number/Name)** H70 / *Human Fact Eng Sys Dev*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H70: *Human Fact Eng Sys Dev*	-	23.755	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	23.755

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
Program Element (PE) 0602143A Soldier Lethality Technology
* Project AY6 Soldier Squad Small Arms Armaments Technology
* Project BB7 Exoskeleton: technology for Man-Machine Interface
* Project BC3 Soldier Decision Making & Comms Performance Tech
* Project BE8 Synthetic Training Environment (STE) Technology
PE 0602145A Next Generation Combat Vehicle Technology
* Project BF6 Crew Augmentation and Optimization Tech

A. Mission Description and Budget Item Justification

This Project conducts applied research on human factors to maximize the effectiveness of Soldiers in concert with their equipment. The resulting data are the basis for weapon systems and equipment design standards, guidelines, handbooks, and Soldier training as well as manpower requirements to improve equipment operation and maintenance. Application of this research will yield reduced workload, fewer errors, enhanced Soldier protection, user acceptance, and allows the Soldier to extract the maximum performance from the equipment.

Major efforts research sources of stress, potential stress moderators, and intervention methods, and identify and quantify human performance measures and methods to address current and future warrior performance issues. Individual efforts exploit adaptive learning methods and strategies, enhance and validate human performance modeling tools; investigate integration of advanced concepts in crew stations designs, optimizes interfaces for information systems and improves human robot interaction (HRI) in a full mission context.

Results of these efforts are transitioned to the Research, Development, and Engineering Centers, the Program Executive Offices (PEO) & Program Managers, Army Training and Doctrine Command (TRADOC), Army Medical Command (MEDCOM), Human Systems Integration (HSI) Directorate (Army G1), and Army Test and Evaluation Command (ATEC).

Efforts in this Project support the Under Secretary of Defense for Research and Engineering Science and Technology priorities and the Army Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Interfaces for Collaboration and Decision Making	2.800	-	-
Description: This effort looks at the study of how networks influence, and are influenced by, human behavior in the context of military decision making. The studies, which range from computational modeling to networked simulations in a laboratory			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*	**Project (Number/Name)** H70 / *Human Fact Eng Sys Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
environment, to large-scale simulation exercises, will investigate the effects of technology on information flow, cognitive workload, team collaboration, organizational effectiveness, situational awareness, and decision making.			
Title: Human Performance Modeling ***Description:*** Enhance human performance modeling tools to enable system analysis that will inform system design early in the acquisition process. These tools will allow the identification of design flaws that can be mitigated to reduce workload and human errors and increase user acceptance of developing technologies allowing the Soldier to extract the maximum performance from the equipment. Collect and analyze empirical data on human perception (vision and hearing) to support human and system performance models used for equipment design and training.	1.025	-	-
Title: Brain-Computer Interaction ***Description:*** Investigate the use of neurophysiological and behavior-based technologies for enhancing the interaction between Soldiers and systems such as autonomous systems and advanced crew stations. Implement guidelines for algorithms for characterizing Soldier brain activity in operational contexts, and real-time techniques to integrate neurally-based information into systems designs.	1.230	-	-
Title: Dismounted Soldier Performance ***Description:*** Investigate equipment design standards and human performance measures and create guidelines for maneuver team information systems solutions that improve situational understanding and decision cycle time; identify, mature, and quantify human performance limitations to address future warrior performance issues.	1.375	-	-
Title: Human-Robot Interaction ***Description:*** Design human-centered design requirements and technologies for supervision and Soldier interaction with multiple semi-autonomous unmanned vehicles in urban and unstructured environments. This research will be transitioned to U.S. Army TARDEC.	3.068	-	-
Title: Understanding Socio-cultural Influence ***Description:*** Investigate and model cognitive aspects of socio-cultural influences on Soldier/Commander decision making and communication to enhance Soldier performance with systems, within teams and in the mission context. Extend models of individual and teams to societal levels to support regional understanding, training, mission rehearsal, and influence.	2.025	-	-
Title: Continuous Multi-Faceted Soldier Characterization for Adaptive Technologies	1.600	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*	**Project (Number/Name)** H70 / *Human Fact Eng Sys Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort will investigate technologies that provide the foundation for future Army systems to adapt to individual Soldier?s states, behaviors, and intentions in real-time. Develop novel approaches to individualize adaptive systems through enhanced interfaces, interactions, or interventions that capitalize on prediction methods; and decrease time-to-train, augment physical, cognitive, and social performance, and improve human-network interactions.			
Title: Training Effectiveness Research ***Description:*** Novel technologies and their implementation in Army systems may result in demands on Soldiers that exceed their knowledge, skill, or memory capacity. When demands cannot be remediated by human systems integration, training may enable the demands to be met. This effort will identify human operator tasks in complex, intelligent, and emerging systems critical to mission employment of new technologies. The aspects (particularly knowledge and skill) of those tasks will be determined through experimentation and analysis to inform development of training and simulation technologies, fundamental research on the effectiveness of training regimes, and simultaneous task combinations that must be trained.	0.992	-	-
Title: Rapid Soldier Capability Enhancement ***Description:*** Research the relationship of augmentation agents and Soldier performance & behavior. Investigates the effects of augmentation agents (perceptual, cognitive, and/or physical), used either individually or coupled as a system of agents, on Soldier performance, resilience, and training during operationally relevant tasks. Development of guidelines and models for designing and employing augmentation agents. Implementation of guidelines will enhance augmented Soldier performance.	2.760	-	-
Title: Tools for Assessing Human/Intelligent Team Performance ***Description:*** Develop tools for verifying and validating Soldier interactions and overall human-system performance of mixed Soldier-intelligent agent teams, while providing the foundation for a generalizable tool for a broad range of Human-System Integration (HSI) assessments. Focus on flexible, tailor-able analysis tools for laboratory grade, high-resolution assessment of dismount-robot interactions in complex environments.	1.000	-	-
Title: Explainable Intelligence Underlying Efficient Integration of Cognitive Assist Agents ***Description:*** This effort will develop novel methods for joint human / intelligent agent learning and decision making to capitalize on the individual strengths of humans and intelligent agents to improve emergent group performance; and enable rapid, cooperative decision making and learning utilizing machine learning approaches.	2.050	-	-
Title: Soldier Focused Neurotechnologies	2.330	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*	**Project (Number/Name)** H70 / *Human Fact Eng Sys Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: Neurotechnologies for Soldier use are limited by a lack of sufficient tools and methodologies capable of interpreting brain data in real world environments. Research will focus on the development of novel user-transparent data acquisition systems that are comfortable and non-invasive and on the development of robust tools that account for high levels of variance and noise expected in recorded brain data in real-world environments.			
Title: Exoskeleton ***Description:*** Accelerates Soldier lethality and mobility capabilities through exoskeleton systems with improved Soldier compatibility and reduced training requirements. Advances innovative assessment and analysis techniques and metrics that inform hardware design, system control and technology use case objectives. Identifies and matures fundamental assessment protocols for transition to Army Test and Evaluation community.	1.500	-	-
Accomplishments/Planned Programs Subtotals	23.755	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	15.364	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	15.364
048: *Ind Oper Poll Ctrl Tec*	-	0.992	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.992
835: *Mil Med Environ Crit*	-	4.502	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.502
896: *Base Fac Environ Qual*	-	1.870	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.870
F35: *Environmental Quality Applied Research (CA)*	-	8.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	8.000

Note

In Fiscal Year (FY) 2020 this Program Element (PE) is realigned with continuity of effort to the following PEs:
* 0602141A Lethality Technology
* 0602144A Ground Technology
* 0602146A Network C3I Technology

A. Mission Description and Budget Item Justification

This PE investigates and evaluates enabling tools and methodologies that support the long-term sustainment of Army training and testing activities. Specific focus is on maintaining regulatory compliance while limiting future Army liability to installation operations and training, and maintaining resilient and adaptive ranges. Project 048 improves the Army's ability to comply with requirements mandated by federal, state, and local environmental/health laws and to reduce the cost of this compliance. Project 835 develops enabling technologies for advanced life cycle analysis, advanced sensing, technologies to empower rapid fielding of next generation energetics, propellants and munitions with focus on the impacts of new materiel that will enter the Army inventory within the next decade and beyond, and enable decision making based on accurate environmental conditions in sparse data environments. Project 895 focuses on reducing hazardous waste generation through process modification and control, materials recycling and substitution, and developing technologies to predict and mitigate range and maneuver constraints associated with current and emerging weapon systems, doctrine, and regulations. Project 896 investigates technologies for ecosystem vulnerability assessment, and ecosystem analysis, monitoring, modeling, and mitigation to support sustainable use of Army lands to reduce or eliminate environmental constraints to military missions, and develops environmental sensor capabilities to enable rapid collection and analysis of data for real-time environmental situational awareness.

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

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

Technologies developed in this PE are transitioned to PE 0603728A (Environmental Quality Technology Demonstrations).

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	**Date:** February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*

Work in this PE is performed by the Army Engineer Research and Development Center, Vicksburg, MS, and the Army Futures Command (AFC).

B. Program Change Summary ($ in Millions)	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**
Previous President's Budget	19.469	0.000	0.000	-	0.000
Current President's Budget	15.364	0.000	0.000	-	0.000
Total Adjustments	-4.105	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-3.836	-			
• SBIR/STTR Transfer	-0.269	-			

Congressional Add Details ($ in Millions, and Includes General Reductions)

	FY 2019	**FY 2020**
Project: F35: *Environmental Quality Applied Research (CA)*		
Congressional Add: *Mobile Environmental Containment Sensors*	8.000	-
Congressional Add Subtotals for Project: F35	8.000	-
Congressional Add Totals for all Projects	8.000	-

Change Summary Explanation

Funds reprogrammed out for higher priority Army requirements.

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*	**Project (Number/Name)** 048 / *Ind Oper Poll Ctrl Tec*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
048: *Ind Oper Poll Ctrl Tec*	-	0.992	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.992

Note

In Fiscal Year (FY) 2020 this Project is realigned to:
Program Element (PE) 0602144A Ground Technology
* Project BK7 Robotics for Engineer Operations Technology

A. Mission Description and Budget Item Justification

This Project designs and develops tools and methods to enable the Army to reduce or eliminate environmental impacts both in the United States and abroad. These new and innovative technologies are essential for the effective control and reduction of military unique hazardous and non-hazardous wastes on military installations and associated with contingency operations bases worldwide. To develop the required technologies, this Project has a focus on developing sustainable environmental protection technologies that help the Army maintain environmental compliance for sources of pollution such as production facilities, facility contamination, and other waste streams; a focus on Army-unique ecosystem vulnerability assessment, and ecosystem analysis, modeling, adaptation, and mitigation technologies for installations associated with air quality and endangered species management and their impacts on training and testing missions; a focus on designing and developing technologies for deployed forces with environmentally safe, operationally enhanced, and cost effective technologies or processes to achieve maximum diversion, minimization, or volume reduction of base camp and field waste; and a focus on the impacts of new materiel that will enter the Army inventory within the next decade and beyond. The resultant technologies reduce the impact of legal and regulatory environmental restrictions on installation facilities, training and testing lands and ranges, as well as provide a means to avoid fines and facility shutdowns within the United States and reduce environmental impacts to the Warfighter abroad.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Adaptive & Resilient Installations ***Description:*** This effort develops sustainable, cost efficient, and effective facilities; and provides technologies and techniques for achieving resilient and sustainable installation and base operations.	0.992	-	-
Accomplishments/Planned Programs Subtotals	0.992	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*	**Project (Number/Name)** 048 / *Ind Oper Poll Ctrl Tec*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*	**Project (Number/Name)** 835 / *Mil Med Environ Crit*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
835: *Mil Med Environ Crit*	-	4.502	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.502

Note

In Fiscal Year (FY) 2020 this Project is realigned to:
PE 0602144A Ground Technology:
* Project BL5 Expedient Passive Protection Technology
PE 0602146A Network C3I Technology:
* Project AR3 Intelligent Environmental Battlefield Awareness

A. Mission Description and Budget Item Justification

This Project investigates and develops tools and methods to enable the Army to reduce or eliminate environmental impacts both in the United States and abroad. These new and innovative technologies are essential for the effective control and reduction of military-unique hazardous and non-hazardous wastes associated with contingency operations worldwide. These new and innovative technologies empower rapid fielding of next generation energetics, propellants and munitions with focus on the impacts of new materiel that will enter the Army inventory within the next decade and beyond, and deliver the capability to shape and protect Army investments in next generation fires by delivering proactive, scientifically sound risk and environmental impact management strategies. This Project will also provide integrated knowledge of environmental factors in mission planning activities creating a unified, comprehensive and integrated battlefield landscape of future threats, opportunities and impacts to mission success in sparse data environments enabling mission planners to identify the industrial/commercial resources used as components of weapons development. These resultant technologies streamline the acquisition process, enabling rapid fielding of new materials, increase Army readiness through proactive hazard management strategies for military materials, enhance the Army's ability to improve decision-making based on accurate environmental conditions in sparse data environments, and reduce Army liabilities associated with unforeseen environmental impacts.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Life Cycle of Military Materials in the Environment ***Description:*** This effort provides a quantitative means to determine the environmental and human health effects resulting from exposure to existing and emerging compounds and materials produced in Army industrial, field, and battlefield operations or disposed of through past activities. Results of this research will be integrated into the life cycle analysis process.	0.046	-	-
Title: Rapid Risk Analysis of Fires	2.454	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*	**Project (Number/Name)** 835 / *Mil Med Environ Crit*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: Develop proactive environment, safety, and occupational health risk assessment tools to ensure rapid fielding of energetics, propellants, and munitions.			
Title: Intelligent Environmental Battlefield Awareness ***Description:*** Develop technologies to provide geo-environmental infrastructure and hazard awareness in urban environments to provide decision-makers with data and information for mission planning.	2.002	-	-
Accomplishments/Planned Programs Subtotals	4.502	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*	**Project (Number/Name)** 896 / *Base Fac Environ Qual*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
896: *Base Fac Environ Qual*	-	1.870	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.870

Note

In Fiscal Year (FY) 2020 this Project is realigned to:
Program Element (PE) 060146A Network C3I Technology Project:
* Project AR5 Understanding the Environment as a Threat Technology

A. Mission Description and Budget Item Justification

This Project designs and develops tools as well as identification and assessment methodologies for ecosystem vulnerability assessment, analysis, monitoring, modeling, and mitigation to support real-time dynamic environmental situational awareness to enable the Army to reduce or eliminate environmental constraints to military use both in the United States and abroad and how the use of those resources impacts mission support. The Project investigates, designs, and develops novel methods and missions, providing the Army with the technical capability to manage, protect, and improve the biophysical characteristics; and the computational understanding of the Battlefield environment conditions and stressors in order to provide actionable information supporting situational awareness and influencing tactical operations. Technologies within this Project enable insertion of accurate environmental data into current intelligence and planning frameworks creating an integrated picture of the battlespace for operational decision making. This project also enhances environmental reconnaissance with advanced environmental sensing technologies to enable rapid collection and analysis of environmental data providing situational awareness for mission response.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Understanding the Environment as a Threat ***Description:*** This effort advances the state of the science associated with computational understanding of the Battlefield environment conditions and stressors in order to provide actionable information supporting situational awareness for mission planning.	1.870	-	-
Accomplishments/Planned Programs Subtotals	1.870	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*	**Project (Number/Name)** 896 / *Base Fac Environ Qual*

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*	**Project (Number/Name)** F35 / *Environmental Quality Applied Research (CA)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
F35: *Environmental Quality Applied Research (CA)*	-	8.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	8.000

A. Mission Description and Budget Item Justification

Congressional increases supporting the investigation and evaluation of enabling tools and methodologies that support the long-term sustainment of Army training and testing activities

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

Work in this Project is performed by the Army Engineer Research and Development Center, Vicksburg, Mississippi.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Mobile Environmental Containment Sensors	8.000	-
FY 2019 Accomplishments: Mobile Environmental Containment Sensors		
Congressional Adds Subtotals	8.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	51.685	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	51.685
779: *Command, Control And Platform Electronics Tech*	-	9.195	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	9.195
CY2: *Applied Defensive Cyber*	-	7.955	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	7.955
H92: *Communications Technology*	-	34.535	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	34.535

Note

In Fiscal Year (FY) 2020 this Program Element (PE) is realigned, with continuity of effort realigned to the following PEs:
* PE 0602146A Network C3I Technology
* PE 0602213A C3I Applied Cyber

A. Mission Description and Budget Item Justification

This PE researches and investigates communications, mission command (MC), and electronics components, sub-components, software and protocols that provide the Army with enhanced capabilities for secure, mobile, networked communications, assured information delivery, and presentation of information that enables decision-making. Commercial technologies are continuously investigated and leveraged where possible. Project 779 researches and develops MC software, algorithms, protocols, architectures, and devices that enable management of information across the tactical and strategic battle space; provides automated cognitive reasoning and decision making aids; allows timely distribution, presentation/display and use of MC data on Army platforms; and researches alternatives to Global Positioning System (GPS) for positioning, navigation and timing. Project CY2 investigates cyber electromagnetic activities (CEMA), cyber security devices, software and techniques to harden wireless communications networks against cyber-attacks and new mobile networking protocols that afford resilience within our networks to autonomically 'fight through' and/or evade hostile cyber effects. Project H92 supports research in communications components, software, algorithms and protocols, which allow field commanders to communicate on-the-move to/from virtually any location, through a seamless, secure, self-organizing, self-healing network.

Work in this PE complements PE 0601104A (University and Industry Research Centers), PE 0602270A (EW Technology) , PE 0602705A (Electronics and Electronic Devices), PE 0603270A (EW Technology), PE 0603772A (Advanced Tactical Computer Science & Sensor Tech), and PE 0603794A (C3 Advanced Technology).

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

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

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	54.956	0.000	0.000	-	0.000
Current President's Budget	51.685	0.000	0.000	-	0.000
Total Adjustments	-3.271	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-1.800	-			
• SBIR/STTR Transfer	-1.471	-			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*	**Project (Number/Name)** 779 / *Command, Control And Platform Electronics Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
779: *Command, Control And Platform Electronics Tech*	-	9.195	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	9.195

Note

In Fiscal Year (FY) 2020 this Project is realigned to:
Program Element (PE) 0602146A Network C3I Technology
* Project AQ6 Command Applications of Machine Learning Technolog
* Project AQ7 High Tempo Data Driven Decision Tools Technology
* Project AQ9 Expeditionary Data to Decisions Technology
* Project AV6 Airborne Engineering Support Technology
* Project AW1 Autonomous Navigation Technology
* Project AW3 DoD PNT M&S Collaborative Initiative (CI) Technology
* Project AW5 Modular GPS Independent Sensors Technology

A. Mission Description and Budget Item Justification

This Project researches moveable and mobile command post hardware and other components, software and algorithms that enable commanders at all echelons to have more accurate, useful, and timely information and allows them to execute mission command (MC) from anywhere on the battlefield. Emphasis is on advancements to MC computing platforms, with a specific emphasis on positioning, navigation, and timing (PNT); user/computing platform interaction and cognitive burden reduction; informed operations; and commander-centric capabilities, including using automation to augment or supply staff capabilities. This Project researches technologies that support multi-modal man-machine interaction, battle space visualization, positioning and navigation in degraded environments (poor Global Positioning System (GPS) performance), automated cognitive decision aids, real-time collaborative tactical planning tools, open system architectures, and integration concepts which contribute to more efficient expeditionary and uninterrupted operations.

Work in this Project is related to, and fully coordinated with PE 0603772A (Adv Tactical Computer Science & Sensor Technology) / Project 101 (Tactical Command and Control).

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

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

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

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*	**Project (Number/Name)** 779 / *Command, Control And Platform Electronics Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Assured Positioning, Navigation, and Timing (A-PNT) ***Description:*** This effort investigates positioning, navigation and timing sensor and sensor integration technologies to provide position, velocity, and time information to support operational and training requirements, especially in GPS denied/degraded environments. This effort also designs PNT modeling and simulation (M&S) architectures, frameworks and models.	6.344	-	-
Title: Next Generation Mission Command Technologies ***Description:*** This effort investigates, designs and codes software to enable a uniform MC capability and experience for the commander in the command post, on the move in vehicles, or dismounted, increases the situational awareness through software data architectures and algorithms that intelligently share data across low bandwidth networks and across dismounted, mounted and command post platforms, and improves decision making capacity across the battlefield by using software knowledge representation to model mission, enabling artificial intelligence techniques to use the model to automate staff tasks, correlate and analyze information and provide recommendations.	2.851	-	-
Accomplishments/Planned Programs Subtotals	9.195	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*	**Project (Number/Name)** CY2 / *Applied Defensive Cyber*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
CY2: *Applied Defensive Cyber*	-	7.955	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	7.955

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
Program Element (PE) 0602213A Network C3I Technology
* Project 2CY Information Trust Technology
* Project CY6 Autonomous Cyber Technology
* Project CY8 Cyber Sec Applied Research and Exper Partner Tech
* Project CY9 Decoy and Deterrence Technology

A. Mission Description and Budget Item Justification

This Project investigates cyber electromagnetic activities (CEMA), cyber security devices, software and techniques to harden wireless communications networks against cyber-attacks and new mobile networking protocols that afford resilience within our networks to autonomically 'fight through' and/or evade hostile cyber effects. This Project also investigates and applies robust cyber security techniques and applications to advanced communications and networking devices, software, algorithms and protocols utilized within wireless tactical networks to protect against nation state level cyber effects and maintain Warfighter confidence in network information, resources, identities and mission partners by hardening the blue force attack surface.

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Defensive Cyber Operations	6.490	-	-
Description: This effort investigates and applies robust cyber security techniques and applications to advanced communications and networking devices, software, algorithms and protocols utilized within wireless tactical networks to protect against nation state level cyber effects and maintain Warfighter confidence in network information, resources, identities and mission partners by hardening the blue force attack surface. These capabilities will harden the attack surface by ensuring trustworthy software (SW), hardware (HW), information systems, communications and networks. This effort affords resilience within our networks to autonomically 'fight through' and/or evade hostile cyber effects and provide situational understanding (SU) to enable effective mission planning and execution.			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*	**Project (Number/Name)** CY2 / *Applied Defensive Cyber*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Cyber Security Applied Research & Experimentation Partner (AREP) Technology (formerly called the Cyber Collaborative Research Alliance (CRA)) ***Description:*** This effort will take innovative basic research theories from the Cyber CRA and experimentally validate the hypothesis and create proof-of-concept defensive cyber software implementations.	1.465	-	-
Accomplishments/Planned Programs Subtotals	7.955	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*	**Project (Number/Name)** H92 / *Communications Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H92: *Communications Technology*	-	34.535	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	34.535

Note

In Fiscal Year (FY) 2020 this Project is realigned to:
Program Element (PE) 0602146A Network C3I Technology
* Project AM6 Modular RF Communications Technology
* Project AM8 Protected SATCOM Technology
* Project AN3 Non Traditional Waveforms Technology
* Project AN5 Protected SATCOM-WB Global SATCOM Inter Canc Tech
* Project AN9 UNT - Every Receiver is a Sensor Technology
* Project AO2 Stand-In Advanced RF Effects (STARE)
* Project AP7 Comms/Horiz Int for Army Mod Priorities Tech
PE 0602143A Soldier Lethality Technology
* Project AN1 Narrowband SATCOM Technology

A. Mission Description and Budget Item Justification

This Project investigates and applies advanced communications and network devices, software, algorithms and services by leveraging and adapting commercial research and new communications and network sciences work by the Army Research Lab, Network Science Collaborative Technology Alliance or other Basic Research efforts. This Project leverages developments in wireless transport (e.g. mobile radio based communications systems) to design new techniques for improving communications in high radio frequency (RF) interference environments, such as in the presence of electronic warfare (EW), and to increase the communications capacity of terrestrial and satellite communications (SATCOM) systems. This Project also investigates antenna components, materials, designs and configurations to reduce the visual signature of antennas on Soldier, vehicular and airborne platforms and to reduce co-site interference on platforms with multiple transceivers, such as radios and jammers. Additionally, this Project investigates defensive cyber, cyber security devices, software and techniques to harden wireless communications networks against cyber attacks and new mobile networking protocols to make wireless, on-the-move (OTM) communications networks more responsive to user needs. Beginning in FY19 cyber efforts are being reported in Project CY2. This Project also investigates software and techniques that improve the ability of the Soldier to manage and maintain complex, dynamic networks; and it designs spectrum management software tools to make more efficient use of the congested RF spectrum. This Project also designs new technology and techniques to lower the size, weight, power and cost of networking systems deployed on Army platforms.

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

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

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*	**Project (Number/Name)** H92 / *Communications Technology*

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Communications, Adaptive Networks to Improve Maneuver Operations, formerly Networking to Improve Maneuver and Expeditionary Operations ***Description:*** This effort investigates new capabilities to provide a range of robust, reliable, scalable, agile, interoperable and resource efficient communications capabilities to forces on the move. These capabilities allow forces to conduct maneuver operations, develop situational understanding, and sustain operations while maintaining freedom of movement.	14.705	-	-
Title: Communications, Robust Tactical Systems, formerly Uninterrupted Communications ***Description:*** This effort designs and matures components, software and algorithms that enable Army tactical wireless networks to provide assured uninterrupted access to critical communications and information links so that they operate more robustly in congested, contested and competitive electromagnetic environments. These capabilities will result in robust, reliable and secure terrestrial and SATCOM networks with greater survivability in austere, congested and hostile electromagnetic environments while ensuring that the capabilities are interoperable and resource efficient and will allow forces to develop SU and conduct operations to support mission command networks even under adverse operational conditions.	15.030	-	-
Title: Modular Radio Frequency ***Description:*** This effort enables connectivity in contested & congested environments by applying automated networking techniques to modular RF technology & networking techniques to adapt and continue operation under interference signals.	4.800	-	-
Accomplishments/Planned Programs Subtotals	34.535	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602783A / *Computer and Software Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	14.622	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	14.622
Y10: *Computer/Info Sci Tech*	-	14.622	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	14.622

Note

In Fiscal Year (FY) 2020 this Program Element (PE) is realigned with continuity of effort to the following:
* PE 0602145A Next Generation Combat Vehicle Technology
* PE 0602146A Network C3I Technology

A. Mission Description and Budget Item Justification

This PE develops and characterizes information and communications processing software that automates the delivery of information used in planning, rehearsal, and execution by ground commanders. Efforts develop communication/network architectures, software, and the information fusion software necessary to simplify the understanding and interactions from humans to humans, humans to computers, and computers to humans. Research enables enhanced understanding of many information sources and accelerates the decision cycle time for commanders and leaders operating in the mobile, dispersed, highly networked environment envisioned for the future force.

Work in this PE is fully coordinated with PE 0603772A (Advanced Tactical Computer Science and Sensor Technology), and PE 0603794A (C3 Advanced Technology).

This PE supports Army Science and Technology efforts in the Command, Control, Communications, and Intelligence portfolio.

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

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

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602783A / *Computer and Software Technology*

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	14.948	0.000	0.000	-	0.000
Current President's Budget	14.622	0.000	0.000	-	0.000
Total Adjustments	-0.326	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.326	-			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602783A / *Computer and Software Technology*	**Project (Number/Name)** Y10 / *Computer/Info Sci Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Y10: *Computer/Info Sci Tech*	-	14.622	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	14.622

Note

In Fiscal Year (FY) 2020 this Project is realigned to:
Program Element (PE) 0602145A Next Generation Combat Vehicle
* BF8 Artificial Intelligence & Machine Learning Tech
PE 0602146A Network C3I Technology
* AP3 Information Assurance and Network Resiliency Techn
* AR1 Robust, Resilient and Intelligent C3I Technology

A. Mission Description and Budget Item Justification

This Project develops and characterizes information and communications processing software to automate the delivery of information for planning, rehearsal, and execution by ground commanders. Efforts develop communication/network architectures, software, and the information fusion software necessary to simplify the understanding and interactions from humans to humans, humans to computers, and computers to humans. Research enables enhanced understanding of many information sources and accelerates the decision cycle time for commanders and leaders operating in the mobile, dispersed, highly networked environment envisioned for the future force.

Work in this Project is fully coordinated with PE 0603772A (Advanced Tactical Computer Science and Sensor Technology), and PE 0603794A (C3 Advanced Technology).

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Multi-Media Information Processing and Exploration	1.863	-	-
Description: This effort develops and characterizes fusion software to improve the completeness and timeliness of decision-making for Mission Command. The goal of this effort is to develop software applicable to the Distributed Common Ground Station ? Army (DCGS-A) architecture (an integrated architecture of all ground/surface systems) and for next generation analytic capabilities.			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602783A / *Computer and Software Technology*	**Project (Number/Name)** Y10 / *Computer/Info Sci Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Cyber Security & Information Assurance ***Description:*** This effort designs and characterizes software for the protection of information and networks in wireless tactical environments. The goal is to develop software algorithms that detect and defeat malicious activities of adversaries in bandwidth-constrained tactical networks.	4.814	-	-
Title: Context-Based Information Exchange ***Description:*** This effort investigates techniques that integrate local and external information sources, and it applies text and video analytic approaches to support automated intelligence analysis and decision making.	2.286	-	-
Title: Heterogeneous Computing and Computational Sciences ***Description:*** This effort researches and develops software algorithms to allow information processing across different computing hardware platforms. The goal of this research is to provide high performance computing (HPC) / processing capabilities to the Soldier on the battlefield.	1.689	-	-
Title: Machine Learning with Constrained Resources ***Description:*** This effort will research new machine learning data sets 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 autonomous intelligent agent (IA) and joint IA-Human teams. In addition, multi-modal communication approaches will be investigated to ensure effective communications and understanding of intent. The goal of this research is enable joint human-intelligent agent decision making, optimizing the strengths of each in the decision process and creating an adaptive, agile team.	3.967	-	-
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***Description:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.003	-	-
Accomplishments/Planned Programs Subtotals	14.622	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	96.922	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	96.922
855: *Topographical, Image Intel & Space*	-	17.846	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	17.846
H71: *Meteorological Research For Battle Command*	-	5.620	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.620
T40: *Mob/Wpns Eff Tech*	-	31.899	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	31.899
T41: *Mil Facilities Eng Tec*	-	4.521	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.521
T42: *Terrestrial Science Applied Research*	-	5.127	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.127
T45: *Energy Tec Apl Mil Fac*	-	2.909	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	2.909
T53: *Military Engineering Applied Research (CA)*	-	29.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	29.000

Note

In Fiscal Year (FY) 2020 this Program Element (PE) is realigned with continuity of effort to following:
* PE 0602144A Ground Technology
* PE 0602145A Next Generation Combat Vehicle Technology
* PE 0602146A Network C3I Technology
* PE 0602150A Air and Missile Defense Technology

A. Mission Description and Budget Item Justification

This PE investigates and advances technologies, techniques, and tools for representation of the physical and human environment for use in military planning and operations; for characterizing geospatial, atmospheric, and weather conditions and impacts on systems and military missions; for conducting mobility, counter-mobility, survivability, and force protection planning and operations; and for enabling secure, sustainable, energy efficient facilities. Research focuses on special requirements for battlefield visualization, tactical decision aids, weather intelligence products, and capabilities to exploit space assets. Project 855 conducts geospatial research and development supporting a standard sharable geospatial foundation enabling a common operating environment across mission and command systems. Project H71 supports the materiel development, testing, and operations communities in evaluating the impacts of weather and atmospheric obscurants on military materiel and operations. Project T40 advances force protection technologies across the range of military operations, including expedient protection and hardened construction to defeat complex threats. This Project also designs and develops software and hardware to identify and mitigate ground obstacles for manned and unmanned vehicles; characterizes austere navigation environments, including complex urban environments, and designs and develops materiel solutions, including rapidly emplaced bridging and expedient repair technologies, to allow austere port and airfield entry of forces; and builds and uses modeling and simulation tools to advance

understanding of the interactions of weapons/munitions and novel defeat methodologies with protective construction and critical infrastructure. Project T41 investigates application of technologies to enable garrison/post commanders to plan, monitor, and operate facilities more efficiently, cost-effectively, securely, and sustainably; creates tools (including advanced models and simulations) that provide a framework for making trades and decisions; and supports research to assess non-combat population characteristics and status from social and cultural perspectives to achieve mission objectives. Project T42 develops and validates models and simulations to understand the impacts of the physical environment on the performance of forces, ground and air vehicles, and sensors; as well as the impact of natural and man-made changes in the environment on military operations. Project T45 investigates materials, components, and systems that have potential to reduce energy losses in buildings and shelters; and potential to detect and mitigate consequences of contaminants, such as bacteria and molds, in air handling equipment and building materials.

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

Research is transitioned to PE 0603734A (Military Engineering Advanced Technology).

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

Work in this PE is performed by the Army Engineer Research and Development Center (ERDC) and the Army Futures Command (AFC).

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	101.124	0.000	0.000	-	0.000
Current President's Budget	96.922	0.000	0.000	-	0.000
Total Adjustments	-4.202	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-2.894	-			
• SBIR/STTR Transfer	-1.308	-			

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2019	FY 2020
Project: T53: *Military Engineering Applied Research (CA)*		
Congressional Add: *Innovative Construction Materials for the Arctic*	8.000	-
Congressional Add: *Program Increase: Unspecified*	5.000	-
Congressional Add: *Cellulose Nanocomposites Research*	15.000	-
Congressional Add: *Vehicle-born IED Screening*	1.000	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2019	FY 2020
Congressional Add Subtotals for Project: T53	29.000	-
Congressional Add Totals for all Projects	29.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** 855 / *Topographical, Image Intel & Space*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
855: *Topographical, Image Intel & Space*	-	17.846	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	17.846

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
Program Element (PE) 0602146A Network C3I Technology:
* Project AT7 Network-Enabled GeoSpatial and GEOINT Services Tech
* Project AT9 Tactical GeoSpatial Information Capabilities Technology
* Project AU3 Geospatially Enabled Operational Design Technology
* Project AU5 Automated Analytics for Understanding the Operational Environment Technology

A. Mission Description and Budget Item Justification

This Project investigates and advances capabilities for collection, processing, and creation of data and information depicting physical and human terrain, environmental conditions, and relationships in time and space; digital map creation, transmission, and dissemination; and map-based analytics for planning, decision making, and execution. This Project uses non-traditional methods that exploit existing open source text, multi-media, and cartographic materials addressing social, cultural, and economic geography to advance the capability to produce and transmit high fidelity digital maps depicting the physical terrain, human terrain, and environmental conditions. This Project also develops software tools and methods for map-based analytics that allow deeper insights into the effects of the physical terrain, human terrain, and environmental conditions on military operations, to include tactics and effects upon equipment and Soldier performance. This Project explores and advances components and methods that optimize the utility of the Army Geospatial Enterprise (AGE) to the total Army, which provides map and geospatial data, information, and software services to the total force.

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

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

Work in this Project is performed by the Army Engineer Research and Development Center (ERDC), Vicksburg, Mississippi.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: GeoIntelligence - Geospatial Data Collection, Processing, and Decision Support	5.989	-	-
Description: This effort investigates novel map content generation and geo-temporal analytics for the development of geospatially-based decision support tools. This research focuses on automatic inference and the correlation between events and objects (i.e., people, places) through space and time from massive data sets developed in the Geoenabled Computing Environments effort. In addition, the effort investigates advanced models to forecast effects of the physical terrain, human terrain,			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** 855 / *Topographical, Image Intel & Space*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
and environment for applications to the Military Decision Making Process, an analysis that informs course of action development and evaluation of tactics, equipment, and mission risk.			
Title: GeoIntelligence - Geospatial Data Analysis and Decision Support ***Description:*** This effort develops means to collect, process, and visualize very high-fidelity data and information to capture the dynamic effects of the physical and human terrain impacting military ground operations. The research focuses on tactical, rather than national or commercial, remote sensing of physical terrain to achieve the fidelity required for current and future operations. Research includes investigating new methods for effective sensor systems and materials to 'tag' features, items, and people of interest based upon novel and emerging Light Detection and Ranging (LiDAR) sensor systems, innovative LiDAR collection and analysis techniques, and an array of other sensor systems for intermittent and persistent optimal data collection, object identification, and classification for ground operations.	4.923	-	-
Title: Human Geography - Spatial Reasoning, Analysis, and Visualization ***Description:*** This effort investigates integration of behavior and population dynamics research and analysis into geospatial frameworks to depict the operational environment including culture, demographics, terrain, climate, and infrastructure. Research exploits existing open source text, leverages multi-media and cartographic materials, and investigates data collection methods to ingest geospatial data directly from the tactical edge to characterize parameters of social, cultural, and economic geography. Results of this research augment existing conventional geospatial datasets by providing the rich context of the human aspects of the operational environment, which offers a holistic understanding of the operational environment for the Warfighter.	3.008	-	-
Title: Geo-enable Computing Environments ***Description:*** This effort develops geospatially-enabled, collaborative mission planning capabilities providing services, data, and information to Army planners, staffs, and leaders. Work leverages Army geospatial enterprise standard data sets and incorporate geo-enabled mission command tools and analytical capabilities.	3.926	-	-
Accomplishments/Planned Programs Subtotals	17.846	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** H71 / *Meteorological Research For Battle Command*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H71: *Meteorological Research For Battle Command*	-	5.620	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.620

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
Program Element (PE) 0602146A Network C3I Technology:
* Project AV7 Atmospheric Modeling and Meterological Technology

A. Mission Description and Budget Item Justification

This Project develops tactical weather and atmospheric effects/impacts algorithms for their integration into battlefield information products. Efforts include high-resolution, local assessments and forecasts of meteorological conditions in near real time including effects of urban and mountainous terrain; analytical tools to assess the impact of the atmosphere to optimize system performance and operations planning and advanced atmospheric sensing applications to characterize and mitigate wind and turbulence in complex terrain. It provides detailed model applications for various effects of the atmosphere on electro-optical and acoustic target detection, location, and identification. This Project develops both physics-based decision aids and rule-based decision support systems for assessing the impacts of weather/ atmosphere across a spectrum of friendly and threat weapons systems, sensors, platforms, and operations. Information can be applied to mission planning and execution, battlefield visualization, reconnaissance surveillance and target acquisition, route planning to maximize stealth and efficiency, web enabled tactical decision aids, and also modeling of environmental impacts for combat simulations and war games.

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

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

This work transitions technologies to the Department of Defense weather and operations modeling community, the United States Air Force 557th Weather Wing to improve their operational weather support to the Army Project Leader-Fire Support Command and Control and Marine Corps Systems Command (MCSC) for field artillery systems, the Project Manager, Distributed Common Ground System-Army (DCGS-A), the Joint Improvised Threat Defeat Agency, the Program Executive Office Aviation/Tactical Airspace Integration System (TAIS).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Atmospheric Characterization, Modeling, and Impacts (formerly Atmospheric Modeling) ***Description:*** This effort develops high resolution, short-range forecasting, and high resolution atmospheric modeling capabilities for mountainous, urban, and forest complex terrain.	5.614	-	-
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.006	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** H71 / *Meteorological Research For Battle Command*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: FY 2018 NDAA SEC 825 MDAP Cost Overrun			
Accomplishments/Planned Programs Subtotals	5.620	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T40 / *Mob/Wpns Eff Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
T40: *Mob/Wpns Eff Tech*	-	31.899	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	31.899

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
Program Element (PE) 0602144A Ground Technology:
* Project BL5 Expedient Passive Protection for Technology
* Project BL7 Power Projection in A2/AD Environments Technology
* Project BL9 Protection from Advanced Weapon Effects Technology
PE 0602145A Generation Combat Vehicle Technology:
* Project BF1 Autonomous Ground Resupply
* Project BG2 Modeling & Simulation for MUMT Technology
PE 0602146A Network C3I Technology:
* Project AR9 Persistent Geophysical Sensing-Infrasound Tech
* Project AT2 Subterranean Detection and Monitoring Technology
PE 0602150A Air and Missile Defense Technology
* Project AE2 Unconventional Countermeasures-Survivability Tech

A. Mission Description and Budget Item Justification

This Project investigates, designs, and develops technologies for adaptive and expedient force protection and projection across the range of military operations. Focus areas include force projection and maneuver, including austere port and airfield entry; prediction, definition, avoidance, or defeat of natural and manmade gaps and obstacles to support ground force operations; scalable weapons effects; and high-resolution representation of near-surface terrain and environment for use with sensor models for target detection and unmanned ground systems (UGS) navigation. This research also provides physics-based representations of ground vehicle mobility, obstacle and barrier placement, survivability, and weapons effects in complex and urban terrain modeling and simulation. Work in this Project increases the protection of soldiers and critical assets from conventional, unconventional, and emerging threats and enables maneuver support of ground forces, while reducing their logistical footprint. This Project supports efforts for overcoming critical capability gaps for operations in a number of environments including dismounted Soldiers conducting missions in urban and subterranean environments, distributed small units, and projection and sustainment of forces across an increasing large battlefield.

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

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

Work in this Project is performed by the Army Engineer Research and Development Center (ERDC), Vicksburg, Mississippi.

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T40 / *Mob/Wpns Eff Tech*

This work is fully coordinated with and complementary to PE 0603734A (Military Engineering Advanced Technology). Autonomous ground resupply activities are coordinated in collaboration with the U.S. Army Ground Vehicle Systems Center (GVSC) through PE 0603005A (Combat Vehicle and Automotive Advanced Technology) / Project 515 (Robotic Ground Systems), PE 0602601A (Combat Vehicle and Automotive Technology) / Project H77 (National Automotive Center), and PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology). Autonomous Ground Resupply activities are also coordinated in collaboration with the Armament Research Development and Engineering Center (ARDEC) through PEs 0603001A (Warfighter Advanced Technology) / Project 543 (Ammunition Logistics), PE 06043639A (Weapons and Munitions - Advanced Development) / EC3 (Ammunition Logistics Prototyping), and 0605805A (Munitions Standardization, Effectiveness and Safety) / Project 297 (Mun Survivability & Log). Unconventional Countermeasure activities are coordinated with PE 0602720A (Environmental Quality Technology) / Project 835 (Mil Med Environ Crit) and PE 0603728A (Environmental Quality Technology Demonstrations) / Project 03E (Environmental Restoration Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Adaptive Protection ***Description:*** This effort develops new analytical techniques, advanced materials, and integrated protection systems to support the protection of critical assets on the battlefield. Technology development efforts include techniques and materials to protect fixed and semi-fixed assets and soldiers in complex, urban and contested environments; techniques to increase survivability through unconventional means and advanced hardening material solutions; and techniques to identify subterranean threats against forces and critical assets.	13.550	-	-
Title: Austere Entry and Maneuver ***Description:*** This effort investigates, designs, and creates tools and technologies that identify, assess, and monitor structural and functional suitability of theater access points and infrastructure. This effort investigates materials and models to rapidly repair or construct infrastructure to support power projection and maneuver. This effort creates tools that allow planning of distributed sustainment nodes and tactical logistics resupply networks across the complex, contested battlefield. This effort, investigates techniques and creates tools to simulate manned/unmanned tactical maneuver and mobility of small disbursed units in complex and urban terrains.	13.103	-	-
Title: Environmental Impacts on Sensor Performance ***Description:*** This effort investigates, designs, and creates physics-based, multiscale numerical models of the geo-environment and synthetic environments representing geo-environment impacts on various sensor modalities and systems. These enable the development of sensors and sensor algorithms for object or target detection, sensor-target pairing, unconventional countermeasures experiments, and autonomous navigation and tactical behaviors in unmanned ground systems. This effort further investigates the design of non-line-of-sight sensors for remote areas, including the investigation of coupling between sensors and their environment for understanding surface and subsurface activities. This effort supports persistent surveillance and detection capabilities and air missile defense.	3.862	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T40 / *Mob/Wpns Eff Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Materials Modeling ***Description:*** This effort investigates and leverages physics-based computational models and laboratory experiments to understand the relationships between the chemical and micro-structural composition of materials and their performance characteristics when used in protecting facilities.	1.384	-	-
Accomplishments/Planned Programs Subtotals	31.899	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T41 / *Mil Facilities Eng Tec*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
T41: *Mil Facilities Eng Tec*	-	4.521	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.521

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
Program Element (PE) 0602144A Ground Technology:
*Project BK7 Robotics for Engineer Operations Technology

A. Mission Description and Budget Item Justification

This Project investigates and develops technologies and techniques to support robotic and autonomous operations capabilities, ensure sustainable, cost efficient, and effective facilities, and to achieve resilient and sustainable installation and expeditionary operations. The project focuses on facilities and operations technologies directly supporting training, readiness, force projection, force protection, and homeland security. Facility enhancement technologies contribute to cost reductions in the Army facility life cycle process (infrastructure planning, assessment, design, construction, revitalization, sustainment, and disposal), and the supporting installation operations. This work improves the capability of autonomous engineering during combat operations to perform construction and supporting tasks in high risk/threat and dynamic environments, enables installations to support forces to meet transformation goals, improves designs for close battle training facilities, and enhances security of Soldiers, families, and civilians. Technologies evolving from this work include integrated planning and design tools for United States (U.S.) facilities and on-demand expeditionary structures, models predicting water dispersed contaminant effects on facilities and occupants; sustainable facility and base management; collaborative decision support tools; and advanced materials. In addition, technologies from this work will support analysis of socio-cultural and facility issues in contingency operations, including urban environments.

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

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

Work in this Project is performed by the Army Engineer Research and Development Center (ERDC), Vicksburg, Mississippi.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Infrastructure for Combat Operations (Previously titled Adaptive and Resilient Installations) ***Description:*** The Army requires the ability to assess, establish, upgrade, and secure infrastructure while in theatre to enable deployed force operations. This effort provides tools for the assessment of physical and ecological impacts on operations, agile infrastructure modification, and custom designed construction for expeditionary structures on demand.	1.793	-	-
Title: Robotics for Engineer Operations	2.728	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T41 / *Mil Facilities Eng Tec*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: Develop and demonstrate robotic engineer construction equipment capability allowing Engineers to conduct autonomous and semi-autonomous Mobility, Countermobility and Construction missions. This effort supports the Army's Modernization Priority Next Generation Combat Vehicle (NGCV), Maneuver Robotics and Autonomous Systems, and is intended to provide capabilities that enable and increase the effectiveness of future maneuver formations with extended reach (area and time), by enabling increased force survivability by combining manned and robotic teaming in the conduct of cross-domain maneuver in complex terrain while reducing risk to Soldier and units.			
Accomplishments/Planned Programs Subtotals	4.521	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T42 / *Terrestrial Science Applied Research*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
T42: *Terrestrial Science Applied Research*	-	5.127	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.127

Note

In Fiscal Year (FY) 2020 this Project is realigned to:
Program element (PE) 0602146A Network C3I Technology:
* Project AT4 GeoINT - OPS Merge Technology

A. Mission Description and Budget Item Justification

This Project investigates and advances technologies to characterize and respond to impacts of the terrestrial environment on the performance of emerging and deployed Army systems, as well as the impact of natural and man-made changes in the environment on all phases of unified land operations. Research efforts model the dynamics of electromagnetic, acoustic, and seismic propagation in response to changing terrain state and complex terrain features and geometry, and their depiction in geospatial information and mission command systems. Numerical modeling of weather effects on terrain properties supports intelligence preparation of the battlefield products including mobility estimates and intelligence, surveillance, and reconnaissance planning. This effort integrates terrain knowledge and weather forecast in a mission context to provide geospatial information and mission command-delivered solutions to the Soldier. The understanding gained and products developed improve the ability to predict signature (emitter) behavior and sensor performance in complex operational environments, and support materiel development, sensor performance products for tactical decision-making, and visualization for mission command.

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

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

Work in this Project is performed by the Army Engineer Research and Development Center (ERDC), Vicksburg, Mississippi.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Tactical Augmented Reality for Operational Technologies - 3D Terrain	1.000	-	-
Description: This effort partnered with Communications - Electronics Research, Development, and Engineering Center, designs and exploits an innovative geospatial framework for storage, extraction, processing and visualization of high-resolution three-dimensional (3D) terrain data for tactical visualization systems, helmet-mounted, and other displays. Research results will mature technological components to enable a leap ahead in Soldier situational awareness by introducing geo-registered geospatial cues with military symbology on the Soldiers view of the real world, enabling more rapid decision making by the mounted and dismounted Warfighters.			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T42 / *Terrestrial Science Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Geospatial Analytics for High Resolution Enriched Terrain ***Description:*** This effort investigates and develops enhanced and automated analytical capabilities to update, revise and complete 3D high-resolution geospatial representations of the time-stable objects and geometries of complex and urban terrain (e.g. buildings) for the common operating picture. Research results, a new and innovative set of geospatial models, apply to a variety of planning and visualization capabilities for enabling the Soldier to effectively operate with greater situational awareness in complex terrain and dense urban environments.	3.000	-	-
Title: Geospatial Representation of Dynamic Phenomena ***Description:*** This effort investigates and develops capabilities for automated techniques and tools to identify, characterize, and visualize dynamic geospatial features (e.g., non-combatant clutter) to selectively overlay on high-resolution 3D geospatial representations of infrastructure and terrain surfaces for the Common Operating Picture and tactical displays. These dynamic geospatial features include natural and man-made ephemeral conditions affecting military operations (e.g., obstacles, traffic, population, degraded visual environment, snow, ephemeral water bodies, etc.), such as movement and maneuver, and sensor performance.	1.127	-	-
Accomplishments/Planned Programs Subtotals	5.127	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T45 / *Energy Tec Apl Mil Fac*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
T45: *Energy Tec Apl Mil Fac*	-	2.909	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	2.909

Note

In Fiscal Year (FY) 2020 this Project is realigned to:
Program Element (PE) 0602144A Ground Technology:
* Project BK7 Robotics for Engineer Operations Technology

A. Mission Description and Budget Item Justification

This Project investigates and evaluates technologies necessary for secure, efficient, sustainable military installations and expeditionary structures, emphasizing systems protection in response to evolving needs, including autonomous and semi-autonomous mobility, countermobility and construction. Technologies and processes are also applied to the Army's industrial base to maintain its cost-effective readiness for munitions production and training, and in the theater of operations to reduce logistical footprint. This effort investigates technologies to assess, establish, upgrade, and secure infrastructure while in theatre to enable deployed force operations, develops methods to optimize sustainable operations and maintenance to minimize lifecycle costs, and provides capabilities that enable future maneuver formations. In addition, technologies from this work mature a better understanding of critical infrastructure interdependencies to support sustainable and flexible facility operations and evolving mission requirements.

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

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

Work in this Project is performed by the Army Engineer Research and Development Center (ERDC), Vicksburg, Mississippi.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Robotics for Engineer Operations	2.909	-	-
Description: Develop and demonstrate robotic engineer construction equipment capability allowing Engineers to conduct autonomous and semi-autonomous Mobility, Countermobility and Construction missions. This effort supports the Army's Modernization Priority Next Generation Combat Vehicle (NGCV), Maneuver Robotics and Autonomous Systems, and is intended to provide capabilities that enable and increase the effectiveness of future maneuver formations with extended reach (area and time), enabling increased force survivability by combining manned and robotic teaming in the conduct of cross-domain maneuver in complex terrain while reducing risk to Soldier and units.			
Accomplishments/Planned Programs Subtotals	2.909	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T45 / *Energy Tec Apl Mil Fac*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T53 / *Military Engineering Applied Research (CA)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
T53: *Military Engineering Applied Research (CA)*	-	29.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	29.000

Note

Congressional increases for Program increase

A. Mission Description and Budget Item Justification

Congressional increases supporting the investigation and advancement of technologies, techniques, and tools for representation of the physical and human environment for use in military planning and operations; for characterizing geospatial, atmospheric, and weather conditions and impacts on systems and military missions; for conducting mobility, counter-mobility, survivability, and force protection planning and operations; and for enabling secure, sustainable, energy efficient facilities.

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

Work in this Project is performed by the Army Engineer Research and Development Center (ERDC), Vicksburg, Mississippi.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Innovative Construction Materials for the Arctic ***FY 2019 Accomplishments:*** Innovative Construction Materials for the Arctic	8.000	-
Congressional Add: Program Increase: Unspecified ***FY 2019 Accomplishments:*** Program Increase: Unspecified	5.000	-
Congressional Add: Cellulose Nanocomposites Research ***FY 2019 Accomplishments:*** Cellulose Nanocomposites Research	15.000	-
Congressional Add: Vehicle-born IED Screening ***FY 2019 Accomplishments:*** Vehicle-born IED Screening	1.000	-
Congressional Adds Subtotals	29.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T53 / *Military Engineering Applied Research (CA)*

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602785A / *Manpower/Personnel/Training Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	17.157	20.873	20.766	-	20.766	19.039	19.273	18.670	17.010	0.000	132.788
790: *Personnel Performance & Training Technology*	-	17.157	20.873	20.766	-	20.766	19.039	19.273	18.670	17.010	0.000	132.788

A. Mission Description and Budget Item Justification

This Program Element (PE) designs and validates applied behavioral and social science research to enhance the Soldier Lifecycle (e.g., selection, assignment, training, and leader development) and human relations (e.g., unit cohesion). This PE develops new personnel measures and methods that more fully assess potential and predict performance, behavior, attitudes, and resilience. These technologies also provide innovative and effective Talent Management methods to optimize individual and team performance to ensure the Army can meet mission requirements in uncertain and complex environments. This PE develops new performance measures and metrics for individuals and units, designs innovative training methods, and conducts scientific assessments to inform Human Capital policy and programs. Research in this PE will result in effective non-materiel solutions to help the Army adjust to changes in force size and structure, a variety of mission demands and contexts, challenges in human relations, and budgetary constraints.

Work in this PE complements PE 0603007A (Manpower, Personnel and Training Advanced Technology).

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas, the Army Vision, the Army's Talent Management Strategy, and the Army Modernization Strategy.

Work is performed by the Army Research Institute (ARI) for the Behavioral and Social Sciences at Fort Belvoir, VA.

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	21.847	20.873	21.268	-	21.268
Current President's Budget	17.157	20.873	20.766	-	20.766
Total Adjustments	-4.690	0.000	-0.502	-	-0.502
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-4.200	-			
• SBIR/STTR Transfer	-0.490	-			
• Adjustments to Budget Years	-	-	-0.502	-	-0.502

Exhibit R-2, **RDT&E Budget Item Justification:** PB 2021 Army	**Date:** February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602785A / *Manpower/Personnel/Training Technology*

Change Summary Explanation

FY19 decrease related to funds reprogrammed out for higher priority Army requirements.

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602785A / *Manpower/Personnel/ Training Technology*	**Project (Number/Name)** 790 / *Personnel Performance & Training Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
790: *Personnel Performance & Training Technology*	-	17.157	20.873	20.766	-	20.766	19.039	19.273	18.670	17.010	0.000	132.788

A. Mission Description and Budget Item Justification

This Project conducts applied behavioral and social science research to enhance the Soldier Lifecycle (e.g., selection, assignment, training, leader development) and human relations (e.g., unit cohesion). This Project develops new personnel measures and methods that more fully assess potential and predict performance, behavior, attitudes, and resilience. These technologies also provide innovative and effective Talent Management methods to optimize individual and team performance to ensure the Army can meet mission requirements in uncertain and complex environments. This Project develops new performance measures and metrics for individuals and units, designs innovative training methods, and conducts scientific assessments to inform Human Capital policy and programs. Research in this Project will result in effective non-materiel solutions to help the Army adjust to changes in force size and structure, a variety of mission demands and contexts, challenges in human relations, and budgetary constraints.

The cited work is consistent with the Under Secretary of Defense for Research and Engineering priority focus areas, the Army Vision, the Army's Talent Management Strategy, Army Human Capital Strategy, and the Army Modernization Strategy.

This Project is renamed from Personnel Performance and Training Technology to reflect the change in work that supports Army priorities.

Work is performed by the United States Army Research Institute (ARI) for the Behavioral and Social Sciences in Fort Belvoir, VA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Talent Assessment and Development	13.000	20.357	20.766
Description: This effort conducts applied research that provides the Army with innovative approaches to personnel assessment, improved prediction and modeling of personnel outcomes (e.g., attrition, retention) and an improved capability to improve prediction and modeling (e.g., potential performance, behaviors, attitudes, and resilience of Soldiers). Conducts applied research to provide the Army with effective leader assessment and development methods to measure, develop, and sustain individual/ leader competencies and performance across the Soldier life cycle. Conducts research to create scientifically valid models, tools and techniques for team assignment and development to optimize team effectiveness in-garrison and future operational environments. ***FY 2020 Plans:*** Conduct research to develop non-cognitive assessments for in-service assignments and initial job-choice for enlisted and officer candidates (e.g., cyber occupations) and other military occupational specialties (MOS) & Branches; conduct research to develop outcome measures for more comprehensive assessment of the effectiveness of personnel and training programs/policy; conduct			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602785A / *Manpower/Personnel/ Training Technology*	**Project (Number/Name)** 790 / *Personnel Performance & Training Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
research to develop methods for assessing and developing complex leader competencies to perform effectively in multi-domain operations (e.g., systems and strategic thinking). ***FY 2021 Plans:*** Will conduct research to develop new proof of concept measures to improve integrated personnel assessments that holistically capture the individual attributes that predict job performance, job satisfaction, resilience, attrition, and continuance; will conduct research to develop evidence-based methods to improve assessments of teams-based assignments, leader competencies, collective performance, and team process enablers. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort			
Title: Team-Based Personnel Assignment and Development ***Description:*** This effort conducts research to create scientifically valid models, tools and techniques to assign individuals to teams to optimize team effectiveness in-garrison and future operational environments. Conduct research to create science-based methods to rapidly build team cohesion and collective performance.	4.157	-	-
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.516	-
Accomplishments/Planned Programs Subtotals	17.157	20.873	20.766

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	55.467	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	55.467
E01: *Warfighter Technology Initiatives (CA)*	-	16.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	16.000
H98: *Clothing & Equipm Tech*	-	29.472	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	29.472
H99: *Joint Service Combat Feeding Technology*	-	4.814	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.814
XW5: *Small Unit Expeditionary Maneuver Technology*	-	5.181	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.181

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is realigned with continuity of effort to the following:
* Program Element (PE) 0602143A Soldier Lethality Technology

A. Mission Description and Budget Item Justification

This PE investigates and develops integrated technologies which improve Soldier and Small Combat Unit survivability, sustainability, mobility, combat effectiveness, and field quality of life and assess the impact of each on Soldier performance. This PE supports the design, development, and improvement of components used for aerial delivery of personnel and cargo (Project 283 Airdrop Adv Tech), combat clothing and personal equipment including protective equipment such as personal armor, helmets, and eyewear (Project H98 Clothing & Equipm Tech), combat rations and combat feeding equipment (Project H99 Joint Service Combat Feeding Technology), expeditionary base camps (Project VT4 Expeditionary Mobile Base Camp Technology), small unit expeditionary maneuver technologies (Project XW5 Small Unit Expeditionary Maneuver Technology). This PE supports the investigation and advancement of critical knowledge and understanding of Soldier physical and cognitive performance. Project E01 Warfighter Technology Initiatives funds Congressional special interest items. The Projects in this PE adhere to Tri-Service Agreements on clothing, textiles, and food with coordination provided through the Cross Service Warfighter Equipment Board, the Soldier and Squad Integrated Concepts Development Team, and the Department of Defense (DoD) Combat Feeding Research and Engineering Board.

Work in this PE is related to, and fully coordinated with, PE 0603001A (Warfighter Advanced Technology), PE 0602105A (Materials Technology), PE 0602618A (Ballistics Technology), PE 0602787A (Medical Technology), PE 0602716A (Human Factors Engineering Technology), 0603004A (Weapons and Munitions Advanced Technology), PE 0603005A (Combat Vehicle and Automotive Advanced Technology), PE 0602784A (Military Engineering Technology), PE 0603125A (Combating Terrorism Technology Development), and PE 0603772A (Advanced Tactical Computer Science and Sensor Technology).

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

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*

B. Program Change Summary ($ in Millions)	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total
Previous President's Budget	56.532	0.000	0.000	-	0.000
Current President's Budget	55.467	0.000	0.000	-	0.000
Total Adjustments	-1.065	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.065	-			

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2019	FY 2020
Project: E01: *Warfighter Technology Initiatives (CA)*		
Congressional Add: *H98 Clothing and Equipment*	5.000	-
Congressional Add: *Thermal Signature Management Technologies*	2.000	-
Congressional Add: *Expeditionary Mobile Base Camp Technology*	8.991	-
Congressional Add: *FY 2018 NDAA SEC 825 MDAP Cost Overrun*	0.009	-
Congressional Add Subtotals for Project: E01	16.000	-
Congressional Add Totals for all Projects	16.000	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** E01 / *Warfighter Technology Initiatives (CA)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
E01: *Warfighter Technology Initiatives (CA)*	-	16.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	16.000

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Warfighter Technology Applied Research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: H98 Clothing and Equipment ***FY 2019 Accomplishments:*** H98 Clothing and Equipment	5.000	-
Congressional Add: Thermal Signature Management Technologies ***FY 2019 Accomplishments:*** Thermal Signature Management Technologies	2.000	-
Congressional Add: Expeditionary Mobile Base Camp Technology ***FY 2019 Accomplishments:*** Expeditionary Mobile Base Camp Technology	8.991	-
Congressional Add: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***FY 2019 Accomplishments:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.009	-
Congressional Adds Subtotals	16.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** H98 / *Clothing & Equipm Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H98: *Clothing & Equipm Tech*	-	29.472	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	29.472

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
Program Element (PE) 0602143A Soldier Lethality Technology
* Project AZ2 Body Armor & Integrated Headborne Technology
* Project AZ9 Soldier Protection Advanced Tech - Detectability
* Project BB4 Dismounted Soldier Survivability Materials
* Project BB5 Physical Augmentation: Tech for Human Interactions
* Project BC2 Next Gen Mobility & Lethality Tech for Warfighters
* Project BB9 Human Performance Tech for Mobility & Lethality
* Project BC6 Human Perf - Tech for Warfighter Enhancement
* Project BD6 Soldier Sys Interfaces/Integration- Sensor Tech

A. Mission Description and Budget Item Justification

This Project investigates fibers, textiles, components, and materials focused on enhancing Soldier survivability from combat threats (flame and thermal, blast and ballistic, multispectral sensor, and laser threats) and environmental threats (e.g., cold, heat, wet, vector, antimicrobial, etc.) to increase operational effectiveness while decreasing the Soldier's physical and cognitive burden. Included are investigations of technologies, novel materials, and test methods related to personnel armor, helmets, hearing protection, eyewear, uniforms, handwear, footwear, and other clothing and individual equipment items. This Project also supports the investigation and development of novel combat identification technologies, electro-textiles for power generation and distribution, the study and exploration of algorithms for autonomous micro and nano robotics and sensors, and human-machine teaming technologies to enhance the dismounted Soldier's Situational Awareness (SA) and Manned-Unmanned Teaming (MUM-T) with autonomous systems. In addition, this Project supports the development and refinement of essential analytic tools needed to predict and/or assess the combat effectiveness of next generation Soldier systems to identify and develop methods to assess human responses to sensory, physical, cognitive, and affective stimuli and stressors.

Efforts in this Project support the Under Secretary of Defense for Research and Engineering Science and Technology priorities and the Army Modernization Strategy.

Work in this Project is coordinated with PE 0602105A (Materials Technology), PE 0602618A (Ballistics Technology), PE 0603001A (Warfighter Advanced Technology), PE 0602787A (Medical Technology Initiatives), and PE 0602716A (Human Factors Engineering Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Soldier Blast, Ballistic, and Sensory Protection	11.256	-	-
Description: This effort supports the investigation of novel materials, component design, and material modeling to design and develop technologies that protect Soldiers against ballistic, blast, and directed energy threats. This effort utilizes a cross-			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** H98 / *Clothing & Equipm Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
disciplinary, human-focused approach to develop technologies which optimize tradeoffs in ballistic and blast protective component design. This effort is fully coordinated with PE 0602787A (Medical Technology) / Project VB4 (System Biology And Network Science Technology), Project 874 (Cbt Casualty Care Tech), PE 0602618A (Ballistics Technology) / Project H80 (Survivability And Lethality Technology), PE0602105A (Materials Technology) / Project H84 (Materials), PE0602716A (Human Factors Engineering Technology) / Project H70 (Human Fact Eng Sys Dev), PE 0603001A (Warfighter Advanced Technology) / Project J50 (Future Warrior Technology Integration), and Project FF6 (Individual Protection). This effort supports the Force Protection Soldier & Small Unit capability research and addresses the Army top challenge of easing overburdened Soldiers in small units.			
Title: Measurement, Prediction, and Improvement of Soldier Performance ***Description:*** This effort provides a comprehensive investigation of human science methods (psychological, anthropometric, and psychophysical) and biomechanical models to assess human responses to sensory, physical, cognitive, and affective stimuli and stressors. This investigation supports the development of human systems design concepts for Soldier equipment and enhances Soldier and small unit physical and cognitive performance. This work is collaborative with PE 0602716A (Human Factors Engineering Technology) / Project H70 (Human Fact Eng Sys Dev)and PE 0602787A (Medical Technology) / Project VB4 (System Biology And Network Science Technology), and Project 874 (Cbt Casualty Care Tech). This effort supports the Force Protection Soldier & Small Unit capability research and addresses the Army top challenge of easing overburdened Soldiers in small units.	8.400	-	-
Title: Advancements in Fibers, Textiles, and Materials for Soldier Protection ***Description:*** This effort focuses on the investigation of technologies and test methods that aid in the design and development of multifunctional protective materials for Soldier clothing and individual equipment. This effort includes the development and maturation of flame, thermal, environmental, and multispectral concealment capabilities, as well as novel desalinization and purification technologies for individual Soldier hydration, combat identification technologies, and electro-textiles for power generation and distribution. This effort supports the Force Protection Soldier and Small Unit capability research. This effort is fully coordinated with PE 0602105A (Materials Technology) / Project H84 (Materials), PE 0602716A (Human Factors Engineering Technology) /Project H70 (Human Fact Eng Sys Dev), and PE 0603001A (Warfighter Advanced Technology) /Project J50 (Future Warrior Technology Integration).	7.400	-	-
Title: Soldier Situational Awareness Technologies ***Description:*** This effort investigates novel technologies that enhance the dismounted Soldier and Small Unit?s SA during missions. Research in the area of advanced algorithms for Soldier deployed sensors and robotics will provide advanced autonomy to enable MUM-T capabilities for the dismounted Small Unit. This effort also investigates advanced human-machine teaming technologies to minimize warfighter dedicated control of robotic assets. Work in this Project is coordinated with PE 0603001A (Warfighter Advanced Technology).	2.400	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** H98 / *Clothing & Equipm Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***Description:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.016	-	-
Accomplishments/Planned Programs Subtotals	29.472	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** H99 / *Joint Service Combat Feeding Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
H99: *Joint Service Combat Feeding Technology*	-	4.814	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.814

Note

In Fiscal Year (FY) 2020 this Project is realigned to:
Program Element (PE) 0602143A Soldier Lethality Technology:
* Project BE3 Joint Service Combat Feeding Technology

A. Mission Description and Budget Item Justification

This Project investigates and develops novel ration packaging, combat feeding equipment/systems, and advanced food processing technologies to prolong shelf-life. This Project also investigates technologies that detect food safety hazards on the battlefield and enhance quality, nutritional content, and the variety of food items in military rations. Efforts funded in this project support all Military Services, the Special Operations Command, and the Defense Logistics Agency. The Army serves as Executive Agent for this Department of Defense (DoD) program, with oversight and coordination provided by the DoD Combat Feeding Research and Engineering Board. Technologies developed within this effort transition to PE 0603001A (Warfighter Advanced Technology) / Project C07 (Joint Service Combat Feeding Tech Demo) for maturation.

Efforts in this Project support the Under Secretary of Defense for Research and Engineering Science and Technology priorities and Army Modernization Strategy.

Work in this Project is fully coordinated with PE 0602787A (Medical Technology) and PE 0603001A (Warfighter Advanced Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Joint Combat Feeding Technologies ***Description:*** This effort designs and develops stabilization techniques and nutrient compositions to maximize the Warfighter's cognitive and physical performance while minimizing nutritional degradation to optimize the Warfighter's health on the battlefield. This effort investigates technologies in support of the Defense Health Agency Veterinary Services (DHA VS) to enhance field detection and identification capabilities of chemical and biological threats in foods. This effort supports the design and development of new threat detection tools and sensors for food inspectors. This effort additionally investigates equipment and energy technologies to expand the capability and reduce the logistics footprint of Joint Service field feeding operations in a wide range of environmental and operational contexts. This work is coordinated with PE 0602787A (Medical Technology) / Project 869 (Warfighter Health Prot & Perf Stnds) and PE 0603001A (Warfighter Advanced Technology) / Project C07 (Joint Service Combat Feeding Tech Demo).	4.811	-	-
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.003	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** H99 / *Joint Service Combat Feeding Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: FY 2018 NDAA SEC 825 MDAP Cost Overrun			
Accomplishments/Planned Programs Subtotals	4.814	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** XW5 / *Small Unit Expeditionary Maneuver Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
XW5: *Small Unit Expeditionary Maneuver Technology*	-	5.181	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.181

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
Program Element (PE) 0602143A Soldier Lethality Technology:
* Project BE3 Joint Service Combat Feeding Technology
* Project BE1 Support Technology to Mission Command

A. Mission Description and Budget Item Justification

The Small Unit Expeditionary Maneuver Technology Project funds the research and investigation of innovative and emerging technologies which provide maneuver capabilities such as precision aerial delivery of cargo and personnel and force projection platforms enabling mission command in all operating environments. This Project provides trusted tactical sustainment for dispersed units in highly mobile dismounted Manned-UnManned Teaming (MUM-T) operations and other complex operating environments. Efforts funded in this Project support all Military Services, the Special Operations Command, and the Defense Logistics Agency. Technologies developed within this effort transition to PE 0603001A (Warfighter Advanced Technology) / Project XW6 (Small Unit Expeditionary Maneuver) for maturation.

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

Project XW5 (Small Unit Expeditionary Maneuver Technology) combines the efforts of Project 283 (Airdrop Adv Tech) and Project VT4 (Expeditionary Mobile Base Camp Technology) within this PE in FY19 to create an integrated expeditionary maneuver research focus area.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Aerial Delivery ***Description:*** This effort designs and develops technologies that enable Soldier and Small Unit mission readiness, survivability, and effectiveness during highly mobile, dispersed operations that may occur in the absence of conventional logistics support. This effort investigates technologies that enhance equipment, materiel, and personnel aerial delivery in an Anti-Access, Area Denial (A2/AD) environments.	3.678	-	-
Title: Expeditionary Maneuver ***Description:*** This effort designs and develops technologies that enable Soldier and Small Unit mission readiness, survivability, and effectiveness during highly mobile, dispersed operations that may occur in the absence of conventional logistics support. This effort investigates system designs and technologies to enable mission command through highly mobile expeditionary maneuver	1.500	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** XW5 / *Small Unit Expeditionary Maneuver Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
platforms, signature management, and production of energy/supplies at the point of consumption to provide small units with the capability to move rapidly, while providing improved protection and extended range.			
Title: FY 2018 NDAA SEC 825 MDAP Cost Overrun ***Description:*** FY 2018 NDAA SEC 825 MDAP Cost Overrun	0.003	-	-
Accomplishments/Planned Programs Subtotals	5.181	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	**Date:** February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
Total Program Element	-	87.229	112.955	95.496	-	95.496	95.558	100.807	102.483	103.020	0.000	697.548
869: *Warfighter Health Prot & Perf Stnds*	-	38.883	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	38.883
870: *Dod Med Def Ag Inf Dis*	-	18.457	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	18.457
874: *Cbt Casualty Care Tech*	-	11.297	0.869	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	12.166
BS7: *Medical Technology (CA)*	-	0.000	13.800	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	13.800
ET4: *Appl Resch in Clinical and Rehabilitative Medicine*	-	9.705	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	9.705
MK4: *Warfigher Health Applied Rsch Technology*	-	0.000	38.392	29.843	-	29.843	30.441	37.412	38.179	39.818	0.000	214.085
MM4: *Cbt Casualty Care Applied Rsch Technology*	-	0.000	17.909	19.424	-	19.424	20.549	21.025	22.541	22.547	0.000	123.995
MM6: *Medical Technologies to Support Dispersed Ops Tech*	-	0.000	12.109	14.417	-	14.417	12.940	14.257	14.016	13.001	0.000	80.740
MM8: *Infectious Diseases and Applied Rsch Technology*	-	0.000	21.661	24.851	-	24.851	25.459	25.021	24.603	24.610	0.000	146.205
MN1: *Applied Sensory Systems Trauma Technology*	-	0.000	7.615	6.961	-	6.961	6.169	3.092	3.144	3.044	0.000	30.025
VB3: *MEDICAL TECHNOLOGY INITIATIVES (CA)*	-	2.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	2.000
VB4: *System Biology And Network Science Technology*	-	1.383	0.600	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.983
XV5: *Medical Capabilities to Support Dispersed Ops*	-	5.504	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.504

Note

In Fiscal Year (FY) 2020, Projects in this Program Element (PE) have been realigned as noted on each applicable R-2A.

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	

A. Mission Description and Budget Item Justification

This Program Element (PE) supports application of knowledge gained through basic research to refine drugs, vaccines, medical devices, diagnostics, medical practices/ procedures, and other preventive measures essential to the protection and sustainment of Warfighter health. Research is conducted in six principal areas: Combat Casualty Care, Military Operational Medicine, Military Relevant Infectious Diseases, Clinical and Rehabilitative Medicine, Medical Capabilities to Support Dispersed Operations, and Systems Biology/Network Sciences. Projects are coordinated with the Defense Health Agency.

Project 869: Warfighter Health Prot & Perf Stnds
Description: Refines knowledge and technologies on screening tools and preventive measures for post-traumatic stress disorder (PTSD), behavioral health problems (e.g., suicide, substance abuse), and mild traumatic brain injuries; physiological monitors and interventions to protect Warfighters from injuries resulting from operational stress; and exposure to hazardous environments and materials.

Project 870: Dod Med Def Ag Inf Dis
Description: Designs and refines drugs, vaccines, medical diagnostic assays/tests devices, other preventive measures for protection and treatment against naturally occurring infectious diseases as identified by worldwide medical surveillance and military threat analysis.

Project 874: Cbt Casualty Care Tech
Description: Identifies and evaluates drugs, biologics (medical products derived from living organisms), medical devices, and associated clinical practices for field trauma care systems, resuscitation, and life support, with emphasis on provision of prolonged field care when medical evacuation and access to definitive surgical care are delayed. Focus is identification of more effective critical care technologies and clinical practices to treat severe bleeding, traumatic brain injury, burns and other combat related injuries. This Project is coordinated with the Defense Health Agency.

Project ET4: Appl Resch in Clinical and Rehabilitative Medicine
Description: Identifies and evaluates drugs, biologics, medical devices, treatments and diagnostics for post-evacuation restorative, regenerative and rehabilitative care, as well as systems for use by field medics and surgeons for ocular trauma. Research focus is on identifying more effective technologies and protocols to treat ocular injury and visual system dysfunction, as well as laboratory and animal studies for regenerating skin, muscle, nerves, vascular and bone tissues for the care and treatment of wounded Service members.

Project MK4: Warfighter Health Applied Rsch Technology
Description: Refines knowledge and technologies on screening tools and preventive measures for PTSD, behavioral health problems, and mild traumatic brain injuries, physiological monitors, and interventions to protect Warfighters from injuries resulting from operational stress and exposure to hazardous environments and materials. Also conducts research on medically valid testing devices and predictive models used for the refinement of Warfighter protective equipment.

Project MM4 Cbt Casualty Care Applied Rsch Technology

Exhibit R-2, **RDT&E Budget Item Justification:** PB 2021 Army	**Date:** February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*

Description: Identifies and evaluates drugs, biologics (medical products derived from living organisms), medical devices and associated clinical practices for field trauma care, resuscitation, and life support with emphasis on provision of prolonged field care when medical evacuation and access to definitive surgical care is delayed. Focus is identification of more effective critical care technologies and clinical practices to treat severe bleeding, traumatic brain injury, burns and other combat related injuries.

Project MM6: Medical Technologies to Support Dispersed Ops Technology
Description: Medical Robotic and Autonomous Systems (Med-RAS) - Research to develop the ability to deliver emergency resupply of Medical material including repair parts peculiar to medical equipment by ground or air, such as blood products, and, utilization of autonomous platforms to perform medical treatment and medical evacuations in dispersed and multi-domain battle environments.

Project MM8: Infectious Diseases Applied Rsch Technology
Description: Applied research to design and refine drugs, vaccines, and other medical countermeasures against naturally occurring infectious diseases as identified by worldwide medical surveillance and capability needs assessments.

Project MN1: Applied Sensory Systems Trauma Technology
Description: Research to understand the influence of stress on the effectiveness of pain relief drugs (analgesics). This Project conducts laboratory and animal studies for the purpose of developing novel, non-opioid drugs to treat pain in the austere battlefield environment with minimal side effects.

Project VB3: Medical Technology Initiatives (CA)
Description: Congressional Special Interest funding for Medical Technology applied research.

Project VB4: System Biology and Network Science Technology
Description: Includes strategic oversight, direction and management of applied research in integrative systems biology of military relevant conditions, and the Systems Biology Collaboration Center (SBCC). The Sys Bio Cube (a biomedical research data integration and analysis system), managed by the SBCC, provides the ability for multi-site collaborative efforts to integrate, visualize and evaluate complex data using innovative technologies. Post-Traumatic Stress Disorder and coagulopathy (a disorder that impairs the blood's ability to form clots) projects have utilized the systems biology analytical tools and visualization within the Sys Bio Cube to inform the development of prognostic indicators, objective diagnostics, and improved and personalized therapeutic strategies more quickly than non-systems approaches. The SBCC also serves as a US Army Medical Research and Development Command (USAMRDC) resource for data sharing and data management for maximizing the value of all research efforts across the Command.

Project XV5: Medical Capabilities to Support Dispersed Ops
Description: Research to design, develop, and improve Med-RAS, Virtual Health for telemedicine and remotely delivered patient care, and unmanned capabilities for providing or supporting combat casualty care in far-forward and dispersed geographic environments. This research includes the design of semi-autonomous and closed-loop combat casualty triage, diagnosis, physiological monitoring, therapeutic intervention, casualty evacuation, telemedicine/ tele-mentoring and emergency medical resupply technologies for integration with emerging multi-purpose Army Robotics and Autonomous Systems (RAS) and Virtual Health/Telemedicine delivery platforms while optimizing the medical logistic footprint.

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	**Date:** February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*

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

Work in this PE is performed by the United States Army Medical Research and Development Command (USAMRDC), Fort Detrick, MD.

All medical applied research is conducted in compliance with Food and Drug Administration (FDA) or Environmental Protection Agency (EPA) regulations. The FDA requires thorough testing in animals (preclinical testing) to ensure safety and, where possible, effectiveness prior to evaluation in controlled human clinical trials (upon transition to Advanced Technology Development). This PE focuses on research and refinement of technologies such as product formulation and purification and laboratory test refinement with the aim of identifying candidate solutions. This work often involves testing in animal models. The EPA also requires thorough testing of products, such as sterilants, disinfectants, repellents, and insecticides to ensure the environment is adequately protected before these products are licensed for use. Program refinement and execution is externally peer-reviewed and fully coordinated with all Services as well as other agencies through the Joint Technology Coordinating Groups of the Armed Services Biomedical Research Evaluation and Management (ASBREM) Community of Interest (COI). The ASBREM COI, formed under the authority of the Assistant Secretary of Defense for Research and Engineering, serves to facilitate coordination and prevent unnecessary duplication of effort within the Department of Defenses (DoD) biomedical research community, as well as their associated enabling research areas.

B. Program Change Summary ($ in Millions)	**FY 2019**	**FY 2020**	**FY 2021 Base**	**FY 2021 OCO**	**FY 2021 Total**
Previous President's Budget	92.003	99.155	94.786	-	94.786
Current President's Budget	87.229	112.955	95.496	-	95.496
Total Adjustments	-4.774	13.800	0.710	-	0.710
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	13.800			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-2.510	-			
• SBIR/STTR Transfer	-2.264	-			
• Adjustments to Budget Years	-	-	0.710	-	0.710

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2019**	**FY 2020**
Project: BS7: *Medical Technology (CA)*		
Congressional Add: *Military Force Vector Borne Health Protection*	-	5.000
Congressional Add: *Heat Stress on Female Soldiers*	-	2.000
Congressional Add: *Burn Patient Transfer System*	-	2.000

Exhibit R-2, RDT&E Budget Item Justification: PB 2021 Army	Date: February 2020
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2019	FY 2020
Congressional Add: *Musculoskeletal Injury and Bone and Muscle Adaption for Military Physical Training*	-	4.800
Congressional Add Subtotals for Project: BS7	-	13.800
Project: VB3: *MEDICAL TECHNOLOGY INITIATIVES (CA)*		
Congressional Add: *Peer-Reviewed Neurotoxin Exposure Treatment Parkinson?s Research Program*	2.000	-
Congressional Add Subtotals for Project: VB3	2.000	-
Congressional Add Totals for all Projects	2.000	13.800

Change Summary Explanation

Funds reprogrammed out for higher priority Army requirements.

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 869 / *Warfighter Health Prot & Perf Stnds*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
869: *Warfighter Health Prot & Perf Stnds*	-	38.883	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	38.883

Note

In Fiscal Year 2020 (FY20) this Project is being realigned to:
Program Element (PE) 0602787A Medical Technology
* Project MK4 Warfighter Health Applied Rsch Technology

A. Mission Description and Budget Item Justification

This Project conducts research to prevent and protect Warfighters from training and operational injuries; refine mechanisms for detection of physiological (human physical and biochemical function) and psychological (mental) health problems; evaluate hazards to head, neck, spine, eyes, and ears; set the standards for rapid return to duty, and determine new methods to sustain and enhance performance across the operational spectrum. This research provides medical information important to the design and operational use of military systems, and this work forms the basis for behavioral, training, pharmacological (drug actions), and nutritional interventions.

The four main areas of study are:

(1) Physiological Health and Performance
(2) Environmental Health and Protection
(3) Injury Prevention and Reduction
(4) Psychological Health and Resilience

This effort is coordinated with and complimentary to work done in PE0602143A Soldier Lethality Technology and PE0603118A Soldier Lethality Advanced Technology.

The cited work is consistent with the Under Secretary of Defense (Research and Engineering) science and technology focus areas and the Army Modernization Strategy.

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

Work in this project is performed by the United States Army Medical Research and Development Command (USAMRDC), Fort Detrick, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Physiological Health and Performance	14.228	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 869 / *Warfighter Health Prot & Perf Stnds*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort evaluates methods for managing and controlling the effects of fatigue on Soldier operational performance and the impact of nutritional strategies to optimize operational performance. Efforts will also contribute to human health and performance optimization and enhancement.			
Title: Environmental Health and Protection ***Description:*** This effort involves applied research addressing the physiological (human physical and biochemical functions) mechanisms of exposure to extreme heat, cold, altitude, and other environmental stressors. This effort establishes scientific evidence for specific and sensitive diagnostics of exertional heat illness to optimize Soldier performance in austere environments. This effort also supports and maturates non-invasive technologies, decision-aid tools, and models to enhance Soldier protection and sustainment across the operational spectrum. This effort provides the scientific basis for developing focused heating and cooling solutions to maintain fine motor dexterity, core temperature, and optimize physical and cognitive performance during cold-weather and hot-humid operations. This effort will develop knowledge and materiel solutions that enable Soldier individualized metabolic assessments and optimization during training and operations.	4.932	-	-
Title: Injury Prevention and Reduction ***Description:*** This effort addresses the Army's number one priority of readiness by improving musculoskeletal injury prevention efforts as well as contributing to preparing Soldiers for potential threats (e.g., directed energy) in and developing capabilities for the multi domain battle environment; evaluates and assesses the effects of repetitive motion during military operations and training on the human body; provides mathematical models to predict the likelihood of physical injuries following continuous operations and muscle fatigue; evaluates current standards for return-to-duty; and establishes improved medical test methods with the goal of rapid return to duty of Soldiers following injury. This effort also develops prevention based strategies and medically based injury criteria for hearing, vestibular (sensory system supporting movement and sense of balance, located in the inner ear), and ocular/facial protection devices, develops and evaluates neurosensory operational risk factors, develops medically based guidelines to assess neurosensory performance and models the effects of acoustic and impact trauma, as stressors on vision and hearing. Efforts will investigate the medical aspects of manned/unmanned teaming (MUM-T) and medical aspects of and protection against directed energy.	6.373	-	-
Title: Psychological Health and Resilience ***Description:*** This effort refines and evaluates early interventions to prevent and reduce combat-related behavioral health problems, including symptoms of Post-traumatic stress disorder (PTSD), depression, anger problems, anxiety, substance abuse, suicide, and other health risk behaviors. This effort assesses and refines tools and interventions to enhance and sustain psychological resilience throughout Soldiers' careers. Efforts also address the health and well-being of families.	13.350	-	-
Accomplishments/Planned Programs Subtotals	38.883	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 869 / *Warfighter Health Prot & Perf Stnds*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / *Medical Technology*	Project (Number/Name) 870 / *Dod Med Def Ag Inf Dis*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
870: *Dod Med Def Ag Inf Dis*	-	18.457	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	18.457

Note

In Fiscal Year 2020 (FY20), this Project is being realigned to:
Program Element (PE) 0602787A Medical Technology
* Project MM8 Infectious Diseases and Applied Rsch Technology

A. Mission Description and Budget Item Justification

This Project conducts applied research for medical countermeasures to naturally occurring infectious diseases that pose a significant threat to the operational effectiveness of forces deployed outside the United States. Effective preventive countermeasures (protective/therapeutic drugs and vaccines and insect repellents and traps) protect the Force from disease and sustain operations by avoiding the need for evacuations from the theater of operations. Diseases of military importance are malaria, bacterial diarrhea, and viral diseases (e.g., dengue fever and hantavirus). In addition to countermeasures, this project funds refinement of improved diagnostic tools to facilitate early identification of infectious disease threats in an operational environment, informing Commanders of the need to institute preventive actions and improve medical care. Major goals are to integrate genomics (deoxyribonucleic acid (DNA)-based) and proteomics (protein-based) as well as other biotechnologies into the refinement of new concepts for vaccine, drug, and diagnostic candidates.

Research conducted in this Project focuses on the following four areas:

(1) Prevention/Treatment of Parasitic (organisms living in or on another organisms) Diseases
(2) Bacterial Disease Threats (diseases caused by bacteria)
(3) Viral Disease Threats (diseases caused by viruses)
(4) Diagnostic Systems and Vector Identification and Control

For the refinement of drugs and biological products, studies in the laboratory and in animal models provide a proof-of-concept for these candidate products, including safety, toxicity (degree to which a substance can damage an organism), and effectiveness, and are necessary to provide evidence to the Food and Drug Administration (FDA) to justify approval for a product to enter into future human subject testing. Additional non-clinical studies are often needed in applied research even after candidate products enter into human testing during advanced technology development, usually at the direction of the FDA, to assess potential safety issues. Drug and vaccine refinement bears high technical risk. Of those candidates identified as promising in initial screens, the vast majority are eliminated after additional safety, toxicity, and/ or effectiveness testing. Similarly, vaccine candidates have a high failure rate, because animal testing may not be a good predictor of human response, and therefore candidate technologies/products are often eliminated after going into human trials. Because of this high failure rate, a continuing effort to identify other potential candidates to sustain a working pipeline of countermeasures is critical for replacing those products that fail in testing.

The cited work is consistent with the Under Secretary of Defense (Research and Engineering) science and technology focus areas and the Army Modernization Strategy.

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 870 / *Dod Med Def Ag Inf Dis*

Work is managed by the United States Army Medical Research and Development Command (USAMRDC) in coordination with the Naval Medical Research Center (NMRC). The Army is responsible for programming and funding all Department of Defense (DoD) naturally occurring infectious disease research requirements, thereby precluding duplication of effort within the Military Departments.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2019**	**FY 2020**	**FY 2021**
Title: Applied Research on drugs and vaccines against parasitic diseases ***Description:*** This effort assesses and improves on candidate drugs coming from the Department of Defense (DoD) discovery program and from other collaborations for prevention and treatment of malaria; to counter the continuing spread of drug resistance to current drugs; assesses currently available drugs for use against cutaneous leishmaniasis (a skin-based disease transmitted by sand flies) in animal models; and select the most effective and safe candidates for continued refinement and possible clinical testing. This effort also conducts studies to investigate new candidate vaccines for preventing malaria and selects the best candidate(s) for continued refinement. A highly effective vaccine would reduce or eliminate the use of anti-malarial drugs and would minimize the progression and impact of drug resistance to current/future drugs.	8.550	-	-
Title: Diagnostic Systems and Vector Identification and Control ***Description:*** This effort designs and prototypes new medical diagnostic and surveillance tools for the field, focusing on bedside and field-deployable diagnostic systems and refines interventions that protect Warfighters from biting insects such as sand flies (transmitters of leishmaniasis) and mosquitoes (transmitters of dengue, Japanese encephalitis, malaria, etc.).	0.414	-	-
Title: Viral Threats Research ***Description:*** This effort designs and tests new vaccine candidates in the laboratory against hemorrhagic fever viruses (i.e., dengue virus, Hantaviruses, Lassa fever virus and Crimean-Congo hemorrhagic fever virus) and assesses other non-vaccine technologies to protect against hemorrhagic fever viruses. Efforts also include establishing and maintaining of clinical trial sites worldwide.	4.049	-	-
Title: Bacterial Threats ***Description:*** This effort conducts studies to refine bacterial countermeasures, including vaccine candidates, to prevent diarrhea (most commonly caused by enterotoxigenic E. coli, Campylobacter and Shigella) and scrub typhus (a debilitating mite-borne disease).	5.444	-	-
Accomplishments/Planned Programs Subtotals	18.457	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 870 / *Dod Med Def Ag Inf Dis*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / *Medical Technology*	Project (Number/Name) 874 / *Cbt Casualty Care Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
874: *Cbt Casualty Care Tech*	-	11.297	0.869	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	12.166

Note

In Fiscal Year 2021 (FY21) this Project is being realigned to:
Program Element (PE) 0602787A Medical Technology
* Project MM4 Cbt Casualty Care Applied Rsch Technology

A. Mission Description and Budget Item Justification

Applied technology development of burn recovery optimization technologies: applied technologies for acute burn treatment that remove dead tissue, prevent infection, and protect the wound from further damage until definitive burn care is available; diagnostic technologies to predict skin graft success or failure, identify patients at heightened risk for scarring, and monitor effectiveness of treatment.

Research conducted in this Project focuses on the following five areas:

(1) Damage Control Resuscitation
(2) Combat Trauma Therapies
(3) Combat Critical Care Engineering
(4) Traumatic Brain Injury (TBI)
(5) Prolonged Field Care

All drugs, biological products, and medical devices are refined in accordance with US Food and Drug Administration (FDA) regulations, which govern testing in animals to assess safety, toxicity, and effectiveness and subsequent human subject clinical trials.

Promising efforts identified in this Project are further matured under PE 0603002A (Medical Advanced Technology) / Project 840 (Combat Injury Mgmt).

The cited work is consistent with the Under Secretary of Defense (Research and Engineering) Science and Technology focus areas and the Army Modernization Strategy.

Work in this Project is performed by the US Army Medical Research and Development Command (USAMRDC), Fort Detrick, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Damage Control Resuscitation	3.150	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 874 / *Cbt Casualty Care Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: This effort develops and refines knowledge products (such as clinical practice guidelines, manuals, protocols, studies, and media), materials, and systems for control of internal bleeding; minimizing the effects of traumatic blood loss; preserving, storing, and transporting blood and blood products; and resuscitation following trauma.			
Title: Combat Trauma Therapies ***Description:*** This effort conducts research to enhance the ability to diagnose, stabilize, and accelerate wound healing and repair of damaged tissue for casualties with severe wounds to the face, mouth and extremities. ***FY 2020 Plans:*** Will develop preclinical models in which to evaluate biomarkers of burn wound severity and healing, and will develop preclinical models in which to evaluate new anti-microbial burn wound therapies. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding realigned to Program Element (PE) 0602787A Medical Technology / Project MM4 Cbt Casualty Care Applied Rsch Technology.	4.002	0.829	-
Title: Combat Critical Care Engineering ***Description:*** This effort refines diagnostic and therapeutic medical devices as well as associated algorithms, software, and data-processing systems for resuscitation, stabilization, life support, surgical support and preservation of vital organ function that can be applied across the pre-hospital, operational field setting, and initial definitive care facilities.	1.097	-	-
Title: Traumatic Brain Injury ***Description:*** This effort supports refinement of drug (includes mature drug technologies and those that are FDA approved for other indications) and therapeutic (i.e., novel use of stem cells or selective brain cooling) strategies to manage TBI resulting from battlefield trauma.	1.511	-	-
Title: Prolonged Field Care ***Description:*** This effort performs applied research to study the physiological implications of delayed medical evacuation and limited access to definitive surgical care in severely injured casualties	1.537	-	-
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:***	-	0.040	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 874 / *Cbt Casualty Care Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Funding transferred in accordance with Title 15 USC ?638			
FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	11.297	0.869	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / *Medical Technology*	Project (Number/Name) BS7 / *Medical Technology (CA)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
BS7: *Medical Technology (CA)*	-	0.000	13.800	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	13.800

Note

Congressional Interest Item funding provided for Medical Technology.

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Medical Technology.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Military Force Vector Borne Health Protection ***FY 2020 Plans:*** Military Force Vector Borne Health Protection	-	5.000
Congressional Add: Heat Stress on Female Soldiers ***FY 2020 Plans:*** Heat Stress on Female Soldiers	-	2.000
Congressional Add: Burn Patient Transfer System ***FY 2020 Plans:*** Burn Patient Transfer System	-	2.000
Congressional Add: Musculoskeletal Injury and Bone and Muscle Adaption for Military Physical Training ***FY 2020 Plans:*** Musculoskeletal Injury and Bone and Muscle Adaption for Military Physical Training	-	4.800
Congressional Adds Subtotals	-	13.800

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / *Medical Technology*	Project (Number/Name) ET4 / *Appl Resch in Clinical and Rehabilitative Medicine*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
ET4: *Appl Resch in Clinical and Rehabilitative Medicine*	-	9.705	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	9.705

Note

In Fiscal Year 2020 (FY20), this Project is being realigned to:
PE 0602787A Medical Technology
* Project MN1 Applied Sensory Systems Trauma Technology

A. Mission Description and Budget Item Justification

This Project identifies and evaluates drugs, biologics (products derived from living organisms), medical devices, treatments and diagnostics for post-evacuation restorative, regenerative and rehabilitative care, as well as systems for use by field medics and surgeons for ocular trauma. Research focuses on identifying more effective technologies and protocols to treat ocular injury and visual system dysfunction, as well as laboratory and animal studies for regenerating skin, muscle, nerves, vascular and bone tissues for the care and treatment of traumatic injury. Research involves extensive collaboration with multiple academic institutions to refine treatments for combat wounds through the Armed Forces Institute of Regenerative Medicine (AFIRM). This Project is coordinated with the Military Departments, Defense Health Agency, and other government organizations to avoid duplication. Research conducted in this Project focuses on Clinical and Rehabilitative Medicine and Battlefield Pain Management.

All drugs, biological products, and medical devices are refined in accordance with Food and Drug Administration (FDA) regulations, which govern testing in animals to assess safety, toxicity, and effectiveness and subsequent human subject clinical trials.

Promising efforts identified in this project are further matured under PE 0603002A (Medical Advanced Technology) / Project ET5 (Adv Tech Dev in Clinical & Rehabilitative Medicine).

The cited work is consistent with the Under Secretary of Defense (Research and Engineering) science and technology focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Medical Research and Development Command (USAMRDC), Fort Detrick, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Clinical and Rehabilitative Medicine	7.320	-	-
Description: This effort conducts laboratory and animal studies for the purpose of regenerating and restoring traumatically-injured tissues, including skin, muscle, nerve, bone tissue, and the ocular system.			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** ET4 / *Appl Resch in Clinical and Rehabilitative Medicine*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Battlefield Pain Management ***Description:*** This effort performs applied research in laboratory and animal studies to develop novel, non-opioid drugs to treat pain in the austere battlefield environment with minimal side effects.	2.385	-	-
Accomplishments/Planned Programs Subtotals	9.705	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** MK4 / *Warfigher Health Applied Rsch Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
MK4: *Warfigher Health Applied Rsch Technology*	-	0.000	38.392	29.843	-	29.843	30.441	37.412	38.179	39.818	0.000	214.085

Note

In Fiscal Year 2020 (FY20), this Project is being realigned from:
Program Element (PE) 0602787A Medical Technology
* Project 869 Warfighter Health Prot & Perf Stnds

A. Mission Description and Budget Item Justification

This Project conducts research to prevent and protect Warfighters from training and operational injuries; refine mechanisms for detection of physiological (human physical and biochemical function) and psychological (mental) health problems; reduce the effects of trauma and promote rapid recovery from acute stress in far forward operational environments; evaluate hazards to head, neck, spine, eyes, and ears; set the standards for rapid return to duty; and determine new methods to sustain and enhance performance and readiness across the operational spectrum. This research provides medical information important to the design and operational use of military systems, and this work forms the basis for behavioral, training, and nutritional interventions.

The four main areas of study are:
(1) Physiological Health and Performance
(2) Environmental Health and Protection
(3) Injury Prevention and Reduction
(4) Psychological Health and Resilience

This effort is coordinated with and complimentary to work done in PE 0602143A Soldier Lethality Technology and PE 0603118A Soldier Lethality Advanced Technology.

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

Work in this Project is performed by the United States Army Medical Research and Development Command (USAMRDC), Fort Detrick, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Physiological Health and Performance	-	16.920	14.402
Description: This effort evaluates methods for managing and controlling the effects of fatigue on Soldier operational performance and the impact of nutritional strategies to optimize operational performance. Efforts will also contribute to new high-priority medical			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** MK4 / *Warfigher Health Applied Rsch Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
investments in human biomedical performance enhancement and medical aspects of manned-unmanned machine teaming (MUM-T). ***FY 2020 Plans:*** Will characterize effects of nutritional energy balance on inflammatory response. Will refine understanding of the environmental influences on eating behavior, to include extreme environmental influences such as heat, cold and altitude. Will determine effects of protein source on protein kinetics and muscle growth and strength. Will evaluate scheduling and fatigue management tools for rotary-wing aviation. Will refine models of aviator risks during Degraded Visual Environment (DVE) operations as a function of neurosensory limitations and physiological condition. Will evaluate degraded Army Manned-Unmanned Teaming operator performance through characterization of medical and work requirements, under operational stressors. Will characterize predictors of resilience during United States Army Special Forces training. Will evaluate exogenous testosterone for maintenance of physiological and psychological performance under conditions of medically relevant hypogonadism (a failure of the gonads, testes in men and ovaries in women, to function properly) induced by high operational tempo military activity. Will provide medical and Solider integration criteria for single-joint exoskeleton to enhance Soldier physical performance in military operations. Will evaluate the effectiveness of slow wave sleep (SWS) augmentation via acoustic stimulation (AS) for enhancing tactical performance and reducing sleepiness during a subsequent period of sustained wakefulness. ***FY 2021 Plans:*** Expeditionary Force Nutrition to Improve Performance ($2.012M) ? Will evaluate the effects of nutritional energy balance on inflammatory response. ? Will refine understanding of the environmental influences on eating behavior, to include extreme environmental influences such as heat, cold and altitude. ? Will evaluate the effects of protein source in protein kinetics and muscle growth and strength. Medical Interventions to Reduce Impact of Fatigue on Performance ($5.356M) ? Will develop a demonstration of the effectiveness of electrical stimulation of the brain for enhancing learning through the consolidation of emotional memories. ? Will evaluate the effectiveness of SWS augmentation via AS for enhancing tactical performance and reducing sleepiness during a subsequent period of sustained wakefulness. Biomedical Performance Enhancement ($6.961M) ? Will evaluate drug-delivered testosterone for maintenance of physiological and psychological performance under conditions of medically relevant hypogonadism (a failure of the gonads, testes in men and ovaries in women, to function properly) induced by high operational tempo military activity.			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** MK4 / *Warfigher Health Applied Rsch Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
? Will provide medical and Soldier integration criteria for single-joint exoskeleton to enhance Soldier physical performance in military operations. ? Will evaluate pharmacological strategies for improving Soldier endurance. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding decrease as a result of project realignment.			
Title: Environmental Health and Protection ***Description:*** This effort involves applied research addressing the physiological (human physical and biochemical functions) mechanisms of exposure to extreme heat, cold, altitude, and other environmental stressors. This effort establishes scientific evidence for specific and sensitive diagnostics of exertional heat illness to optimize Soldier performance in austere environments. This effort also supports and matures non-invasive technologies, decision-aid tools, and models to enhance Soldier protection and sustainment across the operational spectrum. This effort provides the scientific basis for developing focused heating and cooling solutions to maintain fine motor dexterity, core temperature, and optimize physical and cognitive performance during cold- weather and hot-humid operations. This effort will develop knowledge and materiel solutions that enable Soldier individualized metabolic assessments and optimization during training and operations. ***FY 2020 Plans:*** Will evaluate human performance in heat, cold and altitude studies which provide physiological monitoring data for algorithms for an integrated Soldier sensor system to sustain lethality, optimize performance, and improve health and readiness. Will evaluate strategies to improve Soldier health, readiness and mission performance through interventions designed to prevent injuries which result from multi-environmental stressors. Will evaluate interventions to reduce environmental injuries in the heat and cold weather operations. Will develop physiologically based algorithm to detect organ and system toxicity post chemical exposure. Will develop physiologically based algorithm to monitor Soldier performance after exposure to toxic chemicals or hazardous materials. Will develop tools that sustain lethality, improve health, and optimize performance to reduce injuries following exposures to heat, cold, terrestrial altitude and toxic chemicals and hazardous materials for squad leaders and mission planners. ***FY 2021 Plans:*** Operational Risk Planning Tools for Battlefield Environmental Threats ($2.773M) ? Will predict, protect, and enhance performance of the Soldier operating in dense urban and subterranean environments, with a focus on respiratory threats, mental and physical performance, and survivability. ? Will develop studies exposing zebrafish to low oxygen conditions, altered temperatures, and psychological stressors (e.g., predator exposure) to evaluate the potential effectiveness of pharmaceutical interventions to optimize performance. ? Will develop an immersive screening task that, in combination with select measures, will be utilized as screening tool for predicting individuals likely to experience impairment.	-	5.925	7.529

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** MK4 / *Warfigher Health Applied Rsch Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
? Will develop tools to assess medical effects for using personal protective equipment in dense urban and subterranean environments to prevent degraded physical and cognitive performance. Prevention of Soldier Performance Degradation in Extreme Environments (4.687M) ? Will evaluate human performance in heat, cold and altitude studies which provide physiological monitoring data for algorithms for an integrated Soldier sensor system to sustain lethality, optimize performance, and improve health and readiness. ? Will evaluate strategies to improve Soldier health, readiness and mission performance through interventions designed to prevent injuries that result from multi-environmental stressors. ? Will evaluate interventions to reduce environmental injuries in the heat and cold weather operations. ? Will refine and develop tools that sustain lethality, improve health, and optimize performance to reduce injuries following exposures to heat, cold, terrestrial altitude for squad leaders and mission planners. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increase a result of project realignments.			
Title: Injury Prevention and Reduction ***Description:*** This effort addresses the Army's number one priority of readiness by improving musculoskeletal injury prevention efforts as well as contributing to preparing Soldiers for potential threats (e.g., directed energy) in and developing capabilities for the multi domain operations environment. It evaluates and assesses the effects of repetitive motion during military operations and training on the human body; provides mathematical models to predict the likelihood of physical injuries following continuous operations and muscle fatigue; evaluates current standards for return-to-duty; and establishes improved medical test methods with the goal of rapid return to duty of Soldiers following injury. This effort also develops prevention-based strategies and medically-based injury criteria for hearing, vestibular (sensory system supporting movement and sense of balance, located in the inner ear), and ocular/facial protection devices; develops and evaluates neurosensory operational risk factors; develops medically based guidelines to assess neurosensory performance and models the effects of acoustic and impact trauma as stressors on vision and hearing. Efforts will investigate the medical aspects of manned unmanned teaming (MUM-T) and medical aspects of and protection against directed energy. ***FY 2020 Plans:*** Will continue to develop injury based head supported mass criteria, behind helmet blunt trauma, behind armor blunt trauma, and blast exposure injury criteria in order to inform next generation integrated head protection systems, vital torso protection systems, and the next generation bomb suit (program of record). Will develop military relevant fitness and return to duty standards for	-	7.224	4.170

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** MK4 / *Warfigher Health Applied Rsch Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
combat Military Occupational Specialties (MOSs). Will continue to develop medical standards for directed energy threats and develop computational models that will predict organ injury severity and systemic pathological effects. ***FY 2021 Plans:*** Physical Fitness Standards to Prevent Musculoskeletal Injuries ($1.248M) ? Will administer field expedient physical performance tests (PPTs) known to be predictive of performance of common Soldier tasks to Soldiers following lower extremity musculoskeletal injuries. ? Will compare PPT data to known reference values to assess readiness for return to duty (RTD). ? Will use data to assess the prognostic accuracy of PPTs in determining Soldier progression from initial injury to readiness for RTD. Leader Tools to Reduce Musculoskeletal Injury in all Settings ($2.552M) ? Will establish and publish modifiable and non-modifiable factors that impart resilience or contribute to risk for stress fracture and other musculoskeletal injury development during Basic Combat Training (BCT). Leader Decision Aids to Manage Blast Head Injury in All Settings ($0.286M) ? Will determine an objective blood-based biomarker of cognitive status from field studies of blast overpressure and head impact exposures in various heavy weapons military training environments. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding decrease a result of project realignment.			
Title: Psychological Health and Resilience ***Description:*** This effort refines and evaluates tools and early interventions to prevent and reduce the impact of military stressors and combat-related exposures on behavioral health problems, including symptoms of post-traumatic stress disorder (PTSD), depression, anger problems, anxiety, substance abuse, suicide, and other health risk behaviors. This effort assesses and refines tools and interventions to enhance and sustain psychological resilience throughout Soldiers' careers. Efforts also address the health and well-being of families. ***FY 2020 Plans:*** Will continue to assess and characterize risk and resilience markers for Soldiers' psychological and behavioral health. Will identify objective molecular markers for PTSD and PTSD subtypes, treatment response, and return to duty status. Will continue evaluating candidate compounds for treatment of PTSD symptoms through use of a laboratory maintained PTSD animal model. Will develop and test a provider tool kit for standardizing behavioral health provider determinations of Service Members? return to duty status. Will identify and adapt suitable brief acute stress interventions for use in a far-forward setting. Will determine optimal	-	7.506	3.742

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** MK4 / *Warfigher Health Applied Rsch Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
dosing of Cognitive Bias Modification Training, a computerized treatment that reduces specific cognitive biases (e.g., anxiety-sensitivity, threat, and anger). Will continue to develop and refine evidence-based individual (e.g., self-distancing education, emotion regulation, leadership training) and team-level (e.g., regulation of small-team dynamics) interventions that positively influence behavioral health, resilience, and unit readiness. ***FY 2021 Plans:*** Optimal Delivery of Far Forward Psychological Health Care ($1.835M) ? Will develop content and products to deliver behavioral health services oriented to far forward operational settings for the promotion of rapid recovery from acute stress and other behavioral health issues. ? Will develop readiness tools and recommendations to assist in behavioral health readiness decisions made by unit leaders and medics. ? Will develop clinical practice guidelines medics will follow to address the core behavioral health problems encountered in far-forward settings. ? Will develop neurocognitive optimization and enhancement tools to mitigate health and performance decrements during and following stress exposure (i.e., point of psychological injury). Unit-Level Psychological Interventions to Enhance Performance ($1.823M) ? Will develop and evaluate next-generation bystander intervention training to increase unit member response to high-risk behaviors. ? Will determine how transition points place Soldiers at risk. ? Will conduct assessment of Security Forces Assistance Brigades. ? Will develop a method for assessing military-relevant moral injury concerns. ? Will establish components for enhancing behavioral health leadership skills and develop new training. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding decrease a result of project realignment.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.817	-
Accomplishments/Planned Programs Subtotals	-	38.392	29.843

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** MK4 / *Warfigher Health Applied Rsch Technology*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** MM4 / *Cbt Casualty Care Applied Rsch Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
MM4: *Cbt Casualty Care Applied Rsch Technology*	-	0.000	17.909	19.424	-	19.424	20.549	21.025	22.541	22.547	0.000	123.995

Note

In Fiscal Year (FY) 2020, this Project is being realigned from:
Program Element (PE) 0602787A Medical Technology
* Project 874 Cbt Casualty Care Tech

A. Mission Description and Budget Item Justification

This Project refines and assesses concepts, techniques, and materiel that improve survivability and treatment outcomes for Warfighters wounded during combat operations and treated under austere field conditions, including prolonged field care, and during medical evacuation. Combat casualty care research addresses control of severe bleeding; resuscitation and stabilization; advanced automated life support systems suitable for use in forward areas, treatment of severe orthopedic injuries, treatment of severe burns, and combat-related brain injury.

Promising efforts identified in this Project are further matured under PE 0603002A (Medical Advanced Technology).

The cited work is consistent with the Under Secretary of Defense (Research and Engineering) science and technology focus areas and the Army Modernization Strategy.

Work in this Project is performed by the Unites States Army Medical Research and Development Command (USAMRDC), Fort Detrick, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Damage Control Resuscitation	-	3.917	-
Description: This effort develops and refines knowledge products (such as clinical practice guidelines, manuals, protocols, studies, and media), materials, and systems for control of internal bleeding; minimizing the effects of traumatic blood loss; preserving, storing, and transporting blood and blood products; and resuscitation following trauma.			
FY 2020 Plans: Will conduct studies to model optimal treatment for acute traumatic coagulopathy (bleeding disorder) using blood products and drugs. Will conduct studies of new platelet preservative solutions to determine ability to rejuvenate platelets during storage. Will develop assays to characterize stem cell effectiveness for trauma care.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** MM4 / *Cbt Casualty Care Applied Rsch Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Work continues under this same project under program title "Blood and Blood Products."			
Title: Combat Trauma Therapies ***Description:*** This effort conducts research to enhance the ability to diagnose, stabilize, and accelerate wound healing and repair of damaged tissue for casualties with severe burn, facial or extremity wounds. ***FY 2020 Plans:*** Will conduct studies to determine the impact of immune response and life-saving interventions on healing of extremity wounds. Will characterize burn wound fluid proteins to identify potential candidate biomarkers that signal adequacy of wound healing in preclinical animal models. Will evaluate alternative anti-infective/anti-inflammation drugs in animal wound models. Will study technological approaches for diagnosis and treatment of sepsis (life-threatening organ dysfunction caused by the body?s dysregulated response to infection) in a prolonged field care environment. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This work continues under program titled "Severe Burns" under this same project. Decrease due to realignment of previous Combat Trauma Therapies sub-research areas, with the exception of Severe Burns, to new Prolonged Care research area under this same project.	-	4.265	-
Title: Pre-Hospital Tactical Combat Casualty Care ***Description:*** This effort refines diagnostic and therapeutic medical devices, drugs, and new clinical practices for resuscitation, stabilization, and preservation of vital organ function that can be applied by combat medical personnel in the pre-hospital combat setting. ***FY 2020 Plans:*** Will determine whether current battlefield analgesics (pain relief drugs) produce detrimental cardiovascular effects during hemorrhage. Will determine the systemic effects of tourniquet release after prolonged use and identify potential therapeutic targets. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This work continues under program titled "Tactical Combat Casualty Care" under this same project.	-	0.866	-
Title: Traumatic Brain Injury (TBI) ***Description:*** This effort supports refinement of drug (includes mature drug technologies and those that are Food and Drug Administration [FDA] approved for other indications) and therapeutic (i.e., novel use of stem cells or selective brain cooling) strategies to manage TBI resulting from battlefield trauma.	-	1.360	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** MM4 / *Cbt Casualty Care Applied Rsch Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2020 Plans: Will complete animal studies examining neurotherapeutic resuscitation strategies for TBI with polytrauma (injuries to multiple body parts and organ systems). Will complete brain imaging studies using positron emission tomography. Will begin studies evaluating correlative relationships between TBI-induced non-convulsive seizures, TBI-specific biomarkers, and TBI clinical outcomes. Will complete small animal studies evaluating potential beneficial effects of resuscitative endovascular occlusion of the aorta in TBI with polytrauma (will elevate to large animal TBI model if indicated). ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Work continues under program title "Brain Trauma" under the same project.			
Title: Prolonged Care ***Description:*** This effort performs applied research to study the physiological implications of delayed medical evacuation and limited access to definitive surgical care in severely injured casualties. ***FY 2020 Plans:*** Will develop animal models of machine perfusion of vascularly isolated limbs that can be used to evaluate oxygen carrying solutions for limb preservation during extended tourniquet application. Will conduct large animal studies of stem cell products to treat acute respiratory distress syndrome. Will develop and test automated control for partial resuscitative endovascular balloon occlusion of the aorta during application of prolonged cardiovascular support. ***FY 2021 Plans:*** Battlefield sustainment of critical organ function cap set 1 ($3.521M) ? Will perform large animal studies of stem cell products to treat acute respiratory distress syndrome. Future en Route Casualty Care Sustainment System Cap Set ($1.678M) ? Will assess biological effects and safety of new extracorporeal life support technologies (medical devices situated external to the body that provide prolonged organ support in casualties whose vital organs are, due to illness or injury, unable to sustain life). Modular and Automated Battlefield Sustainment of Critical Organ Function Cap Set 2 ($0.880M) ? Will develop sepsis prediction and prolonged field care decision support system. Limb Function Repair and Return to Combat Duty ($0.571M) ? Will evaluate technologies to preserve injured limb tissues and function under prolonged field care conditions. Field Stabilization of Preparation of Evac ($0.493M)	-	7.279	7.186

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** MM4 / *Cbt Casualty Care Applied Rsch Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
? Will evaluate drug and biological compounds to improve extremity wound healing. ? Will begin evaluation of litter carriage performance and post-carry fatigue effects in prolonged field care environments. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding decrease based on level of effort required.			
Title: Blood and Blood Products ***Description:*** This effort develops and refines knowledge products (such as clinical practice guidelines, manuals, protocols, studies, and media), materials, and systems for control of internal bleeding and mitigation of shock; minimizing the effects of traumatic blood loss; preserving, storing, and transporting blood and blood products. ***FY 2021 Plans:*** Synthetic Blood Replacement ($0.987M) ? Will study use of whole blood as treatment for acute traumatic coagulopathy (blood clotting disorder). Next Generation Human-Derived Blood Replacement ($3.949M) ? Will identify new efficacious preservative solutions for platelets and whole blood. ? Will begin study of cellular therapies for treatment of acute radiation sickness combined with traumatic injury. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** This work continues under this same project from previous title "Damage Control Resuscitation." Funding increase a result of level of effort required.	-	-	4.969
Title: Severe Burns ***Description:*** This effort conducts research to enhance the ability to treat acute severe burns at or near the point of injury; protect burn wounds from further injury, infection and inflammation, especially when definitive surgical burn wound care is delayed or unavailable; and accelerate wound healing and return to combat duty. ***FY 2021 Plans:*** Rapid Burn Injury Treatment and Return to Duty Cap Set 1 ($2.272M) ? Will assess novel technologies to prevent burn progression in casualties treated in far forward environments. ? Will develop new severe burn animal models in which to assess new burn treatments along with technologies that quantify burn wound healing rate and measure effectiveness of treatment. Next Generation Rapid Burn Injury Treatment and Return to Duty Cap Set 2 ($0.568M)	-	-	2.883

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** MM4 / *Cbt Casualty Care Applied Rsch Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
? Will develop new treatment approaches to protect burn wounds, prevent infection and inflammation, accelerate healing and restore function. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Decrease due to realignment of previous Combat Trauma Therapies sub-research areas, with the exception of Severe Burns, to new Prolonged Care research area.			
Title: Tactical Combat Casualty Care ***Description:*** This effort refines diagnostic and therapeutic medical devices, drugs, and new clinical practices for hemorrhage control, resuscitation, stabilization, and preservation of vital organ function that can be immediately applied by combat medical personnel in the pre-hospital combat setting. ***FY 2021 Plans:*** Advanced Tactical Combat Casualty Stabilization System Cap Set 2 ($0.423M) ? Will examine therapeutic approaches to preserving kidney function following crush injuries. Tactical Combat Casualty Stabilization System Cap Set 1 ($1.690M) ? Will evaluate catheter-based techniques to control non-compressible hemorrhage. ? Will characterize new animal pain models. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** In FY21, this work is a continuation of work done under the previous title, "Pre-Hospital Tactical Combat Casualty Care", under the same project. The funding increase is a result of project realignment.	-	-	2.153
Title: Brain Trauma ***Description:*** This effort supports refinement of drug (includes mature drug technologies and those that are FDA approved for other indications) and therapeutic strategies to manage brain injury resulting from battlefield trauma. ***FY 2021 Plans:*** Drugs to Prevent and Treat Brain Injury ($1.751M) ? Will perform applied research on nanoparticles to evaluate their use as a drug delivery vehicle. ? Will study therapies that enhance inherent brain healing abilities. ? Will evaluate nicotine as a potential neuroprotective drug. Advanced Medic Brain Injury Diagnostic and Treatment System ($0.438M)	-	-	2.233

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** MM4 / *Cbt Casualty Care Applied Rsch Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
? Will study correlative relationships between brain injury-induced non-convulsive seizures, brain injury-specific biomarkers, and clinical outcomes. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Increase due to allocation of additional funds for study of novel drug delivery platforms.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.222	-
Accomplishments/Planned Programs Subtotals	-	17.909	19.424

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / *Medical Technology*	Project (Number/Name) MM6 / *Medical Technologies to Support Dispersed Ops Tech*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
MM6: *Medical Technologies to Support Dispersed Ops Tech*	-	0.000	12.109	14.417	-	14.417	12.940	14.257	14.016	13.001	0.000	80.740

Note

In Fiscal Year (FY) 2020, this Project is being realigned from:
Program element (PE) 0602787A Medical Technology
* Project XV5 Medical Capabilities to Support Dispersed Ops

A. Mission Description and Budget Item Justification

This Project supports two task areas: 1) Medical Robotic and Autonomous Systems (Med-RAS) focused on developing the ability to deliver emergency resupply of Medical material by ground or air, such as blood products, and, utilization of autonomous platforms to perform medical treatment and medical evacuations in dispersed and multi-domain battle environments. Enables teaming to deliver medical care, and establish medical performance criteria to ensure Soldiers have the physiological, cognitive, and psychological capacity to perform man-machine teaming; and, 2) Virtual Health to enable prolonged care and deciding faster by exploiting emerging communications and information technology for remote telemonitoring and telementoring between providers in Roles of Care 3 and 4 to patients in Roles of Care 1 and 2.

Promising work in this Project will be further matured in PE 0603002A (Medical Advanced Technology) / Project MM7 (Enabling Med Cap to Support Dispersed OPS Adv Tech).

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

Work in this Project is performed by the United States Army Medical Research and Development Command (USAMRDC), Fort Detrick, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Medical Robotic and Autonomous Systems (Med-RAS)	-	7.852	9.904
Description: Research, design, and prototype autonomous and unmanned capabilities to deliver high quality combat casualty care in dispersed operations with limited or absent medical care personnel, and future medical robotic systems capable of providing autonomous combat casualty care while optimizing the medical logistic footprint in far-forward and dispersed geographic environments in support of the Army Multi-Domain Operations concept and the Army Force 2025 and Beyond vision.			
FY 2020 Plans: Will research the design of robotic systems, including physical interfaces and hardware configurations, to effectively implement and control resuscitation and critical care procedures driven by artificial intelligence (AI) and machine learning. Will explore			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** MM6 / *Medical Technologies to Support Dispersed Ops Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
the feasibility of using robotic perception systems to detect and visualize combat casualties for autonomous treatment & extraction. Will research methods for integrating medical systems with emerging unmanned aerial system (UAS) platforms that address patient transport safety concerns, reliability of medical systems in flight, and low-bandwidth and cyber-secure transmission of medical data. Will design and prototype a medic?s AI assisted decision support system using lightweight ruggedized patient monitoring devices, hands-free input of medic observations, and approved joint tactical combat casualty/ prolonged field care guidelines as inputs to provide first responders at the point of injury with adaptive treatment and patient disposition recommendations in the absence of reach-back capabilities for remote telementoring. Will research and design autonomy-based countermeasures to signal latency and constrained bandwidth capabilities for conducting tele-robotic surgical tasks and procedures in low-comms environments.			
FY 2021 Plans: Medical Robotic and Autonomous Systems (Med-RAS) ($9.828M) ? Will design medical robotic systems, including physical interfaces and hardware configurations, for procedures driven by AI and Machine Learning (ML) by: 1) refining polytrauma protocols for animals, 2) conducting human stress testing in a Lower Body Negative Pressure (LBNP) chamber, and 3) performing lab testing of ?soft? robotic noninvasive sensing, force feedback control, needle insertion, patient immobilization, and airway access and insertion. ? Will expand methods for integrating medical systems with unmanned aerial system (UAS) platforms that address patient transport safety concerns, reliability of medical systems in flight, and low-bandwidth and cyber-secure transmission of medical data by 1) testing the patient simulator system on board a unmanned aerial vehicle (UAV) research platform and 2) prototyping and flight testing various communication architectures for closed-loop and tele-operated patient support systems. ? Will refine and further develop Prolonged Field Care guidelines for a prototype AI assisted Decision Support System (DSS). Based on previous year?s research, develop strategies to implement 1) predictive patient state algorithms, 2) ML capabilities to continually improve recommendations, and 3) automated patient encounter and medic interventions through speech to text technologies. ? Will expand research and design of autonomy-based countermeasures to signal latency and constrained bandwidth capabilities for conducting tele-robotic tasks by: 1) integrating force/torque sensing capabilities with the robotic vision system, and 2) designing semi-autonomous surgical protocols. ? Will design layout of a ?CASEVAC kit? subsystem of the Combat Medical Mission Module (CEMM) based on new en route care technologies to include: 1) remotely operated, or semi-autonomous/closed-loop intervention and patient management systems, and 2) enabling medical communications systems and telehealth/Virtual Health and 3) creating computer-aided design (CAD) models and constructing mock-up models.			
FY 2020 to FY 2021 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** MM6 / *Medical Technologies to Support Dispersed Ops Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Funding increase due to additional MedRAS investments in autonomous casualty management, robotic perception for combat casualty care, and telesurgical robotic networks.			
Title: Virtual Health ***Description:*** Develop future Virtual Health enterprise process architectures and integrated physical solutions capable of supporting prolonged field care in conditions with limited or lacking traditional field communications. ***FY 2020 Plans:*** Will research and validate models of novel Virtual Health (VH) enterprise process architectures to provide new intersections of health information and knowledge far forward to support the Multi-Domain Operations. Will research and validate models for the Virtual Health support and integration with autonomous (real time) and/or semi-autonomous patient care capabilities. Will research and validate means to leverage contemporary VH data components to drive future semi-autonomous and autonomous VH system support tools. Will determine strategies for future linkages between the tactical environment and garrison based VH functions. Will determine novel strategies to identify VH consultants based on both availability and proximity to the VH needs. Will explore strategies for VH solutions that align with best practices to counteract threats from electronic warfare (EW). Will explore mechanisms to streamline the engagement with VH solutions by clinical end users in the operational environment. Will research and develop strategies and mechanisms to provide VH solutions when an established synchronous VH consultation is disrupted due to communication failure/outages to include, but not limited to, closed loop systems and machine learning techniques. ***FY 2021 Plans:*** Virtual Health Applications For Multi Domain Operational Environments ($4.438M) ? Will research and validate enterprise architectures for the Virtual Health support and integration with autonomous (real time) and/or semi-autonomous patient care capabilities. ? Will expand research and validate means to leverage contemporary VH data components to drive future semi-autonomous and autonomous VH system support tools. ? Will explore strategies for VH solutions that align with best practices to counteract threats from electronic warfare (EW). ? Will expand mechanisms to streamline the engagement with VH solutions by clinical end users in the operational environment. ? Will expand research mechanisms to provide VH solutions when an established synchronous VH consultation is disrupted due to communication failure/outages to include, but not limited to, closed loop systems and machine learning techniques. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding increase due to level of effort required.	-	3.894	4.513
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638	-	0.363	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** MM6 / *Medical Technologies to Support Dispersed Ops Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
FY 2020 Plans: Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	-	12.109	14.417

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** MM8 / *Infectious Diseases and Applied Rsch Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
MM8: *Infectious Diseases and Applied Rsch Technology*	-	0.000	21.661	24.851	-	24.851	25.459	25.021	24.603	24.610	0.000	146.205

Note

In Fiscal Year (FY) 2020, this Project is being realigned from:
Program Element (PE) 0602787A Medical Technology
* Project 870 DoD Med Def Ag Inf Dis

A. Mission Description and Budget Item Justification

This Project conducts applied (pre-clinical) research for medical countermeasures to prevent naturally occurring infectious diseases that impact operational readiness. The Project builds on basic research to optimize lead countermeasures and determines their safety and efficacy in animal models of infection. Effective preventive countermeasures protect the Warfighter from disease and sustain readiness and operations. Infectious disease threats from parasitic diseases, bacterial diseases, and viral diseases are high priorities for military operations.

Research conducted in this project focuses on the following three areas:

(1) Parasitic Diseases
(2) Bacterial Diseases
(3) Viral Diseases

The cited work is consistent with the Under Secretary of Defense (Research and Engineering) science and technology focus areas and the Army Modernization Strategy.

Work is managed by the United States Army Medical Research and Development Command (USAMRDC) in coordination with the Naval Medical Research Center (NMRC). The Army is responsible for programming and funding all Department of Defense (DoD) naturally occurring infectious disease research requirements, thereby precluding duplication of effort within the Military Departments.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Applied research on drugs and vaccines against parasitic diseases	-	9.981	13.706
Description: Develop and validate malaria preclinical animal models. Demonstrate and optimize prophylactic safety and efficacy in validated malaria preclinical animal models. Down-select lead malaria prophylactic candidates for use in human clinical trials.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** MM8 / *Infectious Diseases and Applied Rsch Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will complete studies in validated animal models to test reformulated triazine lead compound for safety and the dissemination in blood and tissues. These studies are required by the United States Food and Drug Administration (FDA) to enable oral dosing studies in humans. Will complete testing of pyrimidinylguanidine (a newly discovered family of similar chemical compounds that are active against malaria parasites in experimental animals) and primaquine-like compounds in primate malarias to enable initial human testing. Will complete laboratory based analyses of human immune cells and antibodies from Plasmodium falciparum malaria vaccine trials to enable down selection of a lead vaccine for transition to advanced development. Will conduct initial effectiveness trials of potential lead vaccine formulations in primate models of a relapsing malaria, Plasmodium vivax. ***FY 2021 Plans:*** Prevention and Treatment of Parasitic Diseases ($13.621M) ? Will perform test tube and/or cell-based studies to optimize and select the next lead prophylactic and/or treatment candidate for prevention and treatment of malaria. ? Will develop, assess and validate performance parameters of a mouse and/or non-human primate malaria efficacy models. ? Will evaluate the safety and efficacy of lead candidates in validated malaria animal models. ? Will assess technologies for extended release that provides long-term prophylaxis. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort.			
Title: Applied Research to Prevent Viral Diseases ***Description:*** Develop and validate viral disease preclinical animal models. Demonstrate and optimize prophylactic safety and effectiveness in validated viral disease preclinical animal models. Down-select lead viral disease prophylactic candidates for use in human clinical trials. ***FY 2020 Plans:*** Will continue to sustain field sites as part of ongoing research partner efforts in testing dengue vaccine immunogenicity (ability to provoke an immune response) and effectiveness. Will continue to conduct immune cell and antibody assessments in human subjects exposed to dengue by dengue human infection model. Will continue to conduct immune cell and antibody assessments in human subjects immunized with purified inactivated virus and live attenuated virus vaccines. Will continue to explore multi-agent (combination of two or more molecules capable of inducing an immune response) vaccine concepts e.g., pan-hantavirus vaccine, Rift Valley fever, and Crimean Congo hemorrhagic fever vaccine. ***FY 2021 Plans:*** Prevention and Treatment of Viral Diseases ($5.986M) ? Will perform test tube and/or cell-based studies to optimize and select the next lead prophylactic and/or treatment candidate for prevention and treatment of viral diseases.	-	5.525	6.072

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** MM8 / *Infectious Diseases and Applied Rsch Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
? Will develop, assess and validate performance parameters of animal efficacy models of viral diseases. ? Will evaluate the safety and efficacy of lead candidates in validated viral diseases animal models. ? Will assess technologies for extended release that provides long-term prophylaxis. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Increase in funding reflecting level of effort required.			
Title: Applied Research to Prevent Bacterial Diseases ***Description:*** Optimize antigens and platforms for use in animal studies. Evaluate bacterial diarrheal vaccine candidates for safety, effectveness, and immunogenicity in animal models to advance to human clinical trials (ETEC, Shigella and Campylobacter). Examine host/pathogen/vector interactions for scrub typhus and other Rickettsial diseases. ***FY 2020 Plans:*** Will continue to develop and advance existing vaccine candidates against ETEC, Shigella and Campylobacter. Will continue to down select vaccine candidates for testing in animal models of diarrhea caused by ETEC, Shigella and Campylobacter. Will perform an assessment of multivalent (different types) vaccine candidates for ETEC, Shigella and Campylobacter in animal models of diarrhea. Will produce vaccine candidates for testing in humans using Good Manufacturing Processes. Will continue to evaluate the feasibility of clinical field sites for the assessment of vaccine candidates in humans. Will continue to maintain DoD subject matter expertise and laboratory capability in Rickettsiology to effectively detect, diagnose and treat rickettsial disease. ***FY 2021 Plans:*** Prevention and Treatment of Bacterial Diseases ($4.986M) ? Will perform test tube and/or cell-based studies to optimize and select the next lead prophylactic and/or treatment candidate for prevention and treatment of bacterial diarrheal disease. ? Will develop, assess and validate performance parameters of animal efficacy models of bacterial diarrheal and rickettsial diseases. ? Will evaluate the safety and efficacy of lead candidates in validated diarrheal disease animal models. ? Will assess technologies for extended release that provides long-term prophylaxis. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Decrease in funding reflecting level of effort required.	-	5.731	5.073
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:***	-	0.424	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** MM8 / *Infectious Diseases and Applied Rsch Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Funding transferred in accordance with Title 15 USC ?638			
FY 2020 to FY 2021 Increase/Decrease Statement: Funding transferred in accordance with Title 15 USC ?638			
Accomplishments/Planned Programs Subtotals	-	21.661	24.851

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / *Medical Technology*	Project (Number/Name) MN1 / *Applied Sensory Systems Trauma Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
MN1: *Applied Sensory Systems Trauma Technology*	-	0.000	7.615	6.961	-	6.961	6.169	3.092	3.144	3.044	0.000	30.025

Note

In Fiscal Year (FY) 2020, this Project is being realigned from: Program Element (PE) 0602787A Medical Technology
* Project ET4 Appl Resch in Clinical and Rehabilitative Medicine

A. Mission Description and Budget Item Justification

This Project conducts laboratory and animal studies for the purpose of developing novel, non-opioid drugs to treat pain in the austere battlefield environment with minimal side effects. Research to understand the influence of stress on the effectiveness of pain relief drugs (analgesics). All drugs, biological products, and medical devices are refined in accordance with Food and Drug Administration (FDA) regulations, which govern testing in animals to assess safety, toxicity, and effectiveness and subsequent human subject clinical trials.

Promising efforts identified in this Project are further matured under PE 0603002A (Medical Advanced Technology) / Project MN7 (Musculoskeletal Injury Screening Tool Advanced Technology).

The cited work is consistent with the Under Secretary of Defense (Research and Engineering) science and technology focus areas and the Army Modernization Strategy.

Work in this Project is performed by the United States Army Medical Research and Development Command (USAMRDC), Fort Detrick, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Applied Sensory Systems Trauma Technology	-	7.269	6.961
Description: This effort performs applied research in laboratory and animal studies to develop novel, non-opioid drugs to treat pain in the austere battlefield environment with minimal side effects.			
FY 2020 Plans: Will conduct preclinical testing to identify new targets (including peripheral ion channels) and to explore the potential of novel non-opioid drugs for improved pain management strategies. Also will investigate medical countermeasures to directed energy exposures.			
FY 2021 Plans: Applied Sensory Systems Trauma Technology ($3.967M)			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** MN1 / *Applied Sensory Systems Trauma Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
? Will conduct preclinical evaluation of promising non-opioid, side effect-free analgesics in treating post-traumatic, moderate-to-severe pain. These drugs will act on non-opioid targets in the nervous system that inhibit pain signaling without affecting cognitive capability. Applied Sensory Systems Trauma Technology ($3.000M) ? Will identify and assess treatment for unconventionally-acquired brain injury (UBI) threat technologies ? Will conduct UBI human-like animal assessments ? Will validate UBI threat source symptomology and assess injury mechanisms ? Will transition understanding of injury mechanisms to enable direct medical diagnosis, treatment and clinical management. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding decrease based on level of effort required.			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.346	-
Accomplishments/Planned Programs Subtotals	-	7.615	6.961

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / *Medical Technology*	Project (Number/Name) VB3 / *MEDICAL TECHNOLOGY INITIATIVES (CA)*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
VB3: *MEDICAL TECHNOLOGY INITIATIVES (CA)*	-	2.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	2.000

Note

Congressional increase for Peer-Reviewed Neurotoxin Exposure Treatment Parkinson's Research Program

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Neurotoxin Exposure Treatment.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020
Congressional Add: Peer-Reviewed Neurotoxin Exposure Treatment Parkinson?s Research Program	2.000	-
FY 2019 Accomplishments: Peer-Reviewed Neurotoxin Exposure Treatment Parkinson?s Research Program		
Congressional Adds Subtotals	2.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** VB4 / *System Biology And Network Science Technology*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
VB4: *System Biology And Network Science Technology*	-	1.383	0.600	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.983

Note

In Fiscal Year 2021 (FY21) this Project is Eliminated.

A. Mission Description and Budget Item Justification

This Project supports biological and clinical applied research using the data analysis and integration grid (Sys Bio Cube) as an overarching means of complex data usage to solve critical health problems. The primary capability of systems biology (field of study that focuses on complex interactions within biological systems, using a holistic approach) is the integration and analysis of complex human and animal study data and development of computational disease models, using global multi-omic methods to identify and discriminate unique combinations of biological molecules corresponding to clinical conditions (physiologic, immunologic, endocrine, etc.), supporting transition of research to clinical applications. This capability applies a systematic integrated approach to trace progression of illnesses and diseases and has already shown that the approach significantly reduces time, funds and effort invested in medical product development and refinement.

The cited work is consistent with the Under Secretary of Defense (Research and Engineering) science and technology focus areas and the Army Modernization Strategy.

Work in this project is performed by the United States Army Medical Research and Development Command (USAMRDC), Fort Detrick, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Systems Biology	1.383	0.573	-
Description: The core capability for multidisciplinary applied research in systems biology enables integration and analysis of complex data from human and animal studies and development of computational network models, allowing researchers to differentiate among molecular signatures (unique combinations of biological molecules corresponding to clinical conditions) of disease, and supports transition of research to clinical applications for diseases of military relevance. Applied research is being conducted to identify biological networks that are causative of illness in Post-traumatic stress disorder (PTSD) and co-morbidities (presence of one or more diseases or disorders), coagulopathy (impaired ability to clot blood) of trauma, traumatic brain injury, pain, suicide, infectious disease, and immune responses. In particular, the studies of PTSD are directed to refine biomarkers for screening, early diagnosis and therapeutic target discovery.			
FY 2020 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** VB4 / *System Biology And Network Science Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Will complete all studies under this effort. ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding change reflects planned lifecycle of this effort			
Title: FY 2020 SBIR/STTR Transfer ***Description:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 Plans:*** Funding transferred in accordance with Title 15 USC ?638 ***FY 2020 to FY 2021 Increase/Decrease Statement:*** Funding transferred in accordance with Title 15 USC ?638	-	0.027	-
Accomplishments/Planned Programs Subtotals	1.383	0.600	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army			Date: February 2020
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / *Medical Technology*	Project (Number/Name) XV5 / *Medical Capabilities to Support Dispersed Ops*	

COST ($ in Millions)	Prior Years	FY 2019	FY 2020	FY 2021 Base	FY 2021 OCO	FY 2021 Total	FY 2022	FY 2023	FY 2024	FY 2025	Cost To Complete	Total Cost
XV5: *Medical Capabilities to Support Dispersed Ops*	-	5.504	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.504

Note

In Fiscal Year (FY) 2020, this Project is being realigned to:
Program Element (PE) 0602787A Medical Technology
* Project MM6 Medical Technologies to Support Dispersed Ops Tech

A. Mission Description and Budget Item Justification

This project will design, develop, and improve medical robotic and autonomous systems (Med-RAS), Virtual Health for telemedicine and remotely delivered patient care, and unmanned capabilities of providing or supporting combat casualty care in far-forward and dispersed geographic environments. This research includes the design of semi-autonomous and closed-loop combat casualty triage, diagnosis, physiological monitoring, therapeutic intervention, casualty evacuation, telemedicine/ tele-mentoring and emergency medical resupply technologies for integration with emerging multi-purpose Army Robotics and Autonomous Systems (RAS) and Virtual Health/Telemedicine delivery platforms while optimizing the medical logistic footprint.

Promising work in this Project will be further matured in PE 0603002A (Medical Advanced Technology) / Project MM7 (Enabling Med Cap to Support Dispersed OPS Adv Tech).

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

Work in this Project is performed by the United States Army Medical Research and Development Command (USAMRDC), Fort Detrick, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Title: Medical Robotic and Autonomous Systems (Med-RAS) ***Description:*** Research, design, and prototype autonomous and unmanned capabilities to deliver high quality combat casualty care in dispersed operations with limited or absent medical care personnel in support of the Army Multi-Domain Operations concept and the Army Force 2025 and Beyond vision.	1.648	-	-
Title: Virtual Health ***Description:*** To develop future virtual health enterprise process architectures and integrated physical solutions capable of supporting prolonged field care in conditions with limited or lacking traditional field communications.	1.928	-	-
Title: Medical Aspects of Man-Machine Teamining/Medical Robotics	1.928	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2021 Army		Date: February 2020
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** XV5 / *Medical Capabilities to Support Dispersed Ops*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2019	FY 2020	FY 2021
Description: Researched and modeled virtual health enterprise process architectures to provide new intersections of health information and knowledge far forward to support multi-domain operations. Analyzed mechanisms for virtual health secure data transmission and communications in the tactical environment to facilitate use in very limited communication scenarios. Determined key physiological constructs that are predictive of health status and readiness for development of micro-footprint biosensor-based assessment tools.			
Accomplishments/Planned Programs Subtotals	5.504	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A