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**Department of Defense
Fiscal Year (FY) 2020 Budget Estimates**

March 2019



Army

Justification Book of

Research, Development, Test & Evaluation, Army

RDT&E – Volume I, Budget Activity 2

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Army • Budget Estimates FY 2020 • RDT&E Program

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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, \$12,396,895,000.00 to remain available for obligation until September 30, 2021.

OCO for Direct War Costs (\$182,624,000.00): Direct War costs are those combat or direct combat support costs that will not continue to be expended once combat operations end at major contingency locations.

OCO for Enduring Requirements (\$21,500,000.00): OCO for Enduring Requirements are enduring in-theater and in-CONUS costs that will likely remain after combat operations cease, and have previously been funded in OCO.

COST STATEMENT

The following Justification Books were prepared at a cost of \$366,803: 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 6, and Budget Activity 7.

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FY 2020 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 2020 Budget Submitted to Congress to the FY 2019 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:

<i>Budget Activity</i>	<i>OSDPE / Project</i>	<i>Project Title</i>
02	0602145A / BJ9	Autonomous Mobility Tech
02	0602145A / BK2	Virtual Prototyping Technology
02	0602145A / BK3	Next Gen Intelligent Fire Control (NG-IFC) Tech
02	0602145A / BK5	Adv Direct In-Direct Armament Sys (ADIDAS) Tech
03	0603002A / MM7	Enabling Med Cap to Support Dispersed OPS Adv Tech
04	0603619A / BU5	Standoff Volcano Obstacle (SAVO) Adv Tech
04	0603639A / EU3	.50 Caliber All-Purpose Tactical Cartridge (APTC)
04	0603774A / VT8	SOLDIER PRECISION TARGETING DEVICES - ADV DEV
04	0603827A / CF2	Integrated Soldier Systems Prototyping (SL CFT)
04	0604021A / AW7	Electronic Warfare Technology Maturation (MIP)
04	0604115A / AX8	Adv Leth and Accuracy Sys for Med Calber (ALAS-MC)
04	0604115A / AX9	Adv Mobility Experimental Prototype Adv Tech
04	0604115A / AY1	MUM-T Platform Enabler
04	0604115A / AY2	Army Operational Fires
04	0604115A / AY3	Strategic Long Range Cannon
04	0604182A / HX1	Land-Based Hypersonic Missile

04	0604403A / FM3	Future Interceptor
04	0604541A / BT1	Interoperability
04	0604541A / BT2	Command Post Mobility/Survivability
04	0604541A / BT3	Common Operating Environment (COE)
04	0604541A / BT4	Network Technology Maturation Initiatives (NTMI)
04	0604541A / BT5	Integrated Tactical Network/Enterprise Network
04	0604644A / MR1	Mobile Medium Range Missile
05	0604601A / CF3	Integrated Soldier Systems (SL CFT)
05	0604802A / EP2	Shoulder-Launched Munitions
05	0604827A / FK4	Soldier Borne Sensor (SBS)
05	0604854A / HB6	Mobile Howitzer
05	0605041A / CY5	CYBER Situational Understanding
05	0605625A / CF6	Next Generation Combat Vehicle (NGCV)
07	0205778A / EG2	GMLRS Alternative Warheads
07	0607145A / FD5	Apache Product Improvement
07	1203142A / FI8	Protected Anti-JAM Tactical SATCOM

Program Element/Project Restructures:

<u>Budget Activity</u>	<u>Old OSDPE / Project: Title</u>	<u>New OSDPE / Project</u>
01	0601101A / 91A: ILIR-AMC	0601102A / AA1
01	0601101A / F16: ILIR-SMDC	0601102A / AA2
01	0601102A / 305: ATR Research	0601102A / AA9
01	0601102A / 31B: Infrared Optics Rsch	0601102A / AA8
01	0601102A / 52C: Mapping & Remote Sens	0601102A / AB2
01	0601102A / 53A: Battlefield Env & Sig	0601102A / AA7
01	0601102A / 74A: Human Engineering	0601102A / AA4
01	0601102A / 74F: Pers Perf & Training	0601102A / AA4

01	0601102A / ET6: BASIC RESCH IN CLINICAL & REHABILITATIVE MED	0601102A / AB1
01	0601102A / F20: Adv Propulsion Rsch	0601102A / AA6
01	0601102A / F22: Rsch In Veh Mobility	0601102A / AA6
01	0601102A / H42: Materials & Mechanics	0601102A / AA7
01	0601102A / H43: Research In Ballistics	0601102A / AA7
01	0601102A / H44: Adv Sensors Research	0601102A / AA5, AA7, & AA8
01	0601102A / H45: Air Mobility	0601102A / AA6
01	0601102A / H47: Applied Physics Rsch	0601102A / AA9
01	0601102A / H48: Battlespace Info & Comm Rsc	0601102A / AA9
01	0601102A / H52: Equip For The Soldier	0601102A / AA8
01	0601102A / H57: Single Investigator Basic Research	0601102A / AA3
01	0601102A / H66: Adv Structures Rsch	0601102A / AA6
01	0601102A / H67: Environmental Research	0601102A / AA7
01	0601102A / S13: Sci BS/Med Rsh Inf Dis	0601102A / AB1
01	0601102A / S14: Sci BS/Cbt Cas Care Rs	0601102A / AB1
01	0601102A / S15: Sci BS/Army Op Med Rsh	0601102A / AB1
01	0601102A / T22: Soil & Rock Mech	0601102A / AB2
01	0601102A / T23: Basic Res Mil Const	0601102A / AB2
01	0601102A / T24: Signature Physics And Terrain State Basic Research	0601102A / AB2
01	0601102A / T25: Environmental Science Basic Research	0601102A / AB2
01	0601102A / T63: Robotics Autonomy, Manipulation, & Portability Rsh	0601102A / AA6
01	0601102A / T64: Sci BS/System Biology And Network Science	0601102A / AB1
01	0601102A / VR9: Surface Science Research	0601102A / AA7
01	0601103A / D55: University Research Initiative	0601103A / AB3
01	0601104A / EA6: Cyber Collaborative Research Alliance	0601104A / AB7
01	0601104A / F17: Neuroergonomics Collaborative Technology Alliance	0601104A / AB7
01	0601104A / FF5: Distributed Collaborative Intelligent Systems CTA	0601104A / AB7
01	0601104A / FF7: Internet of Battlefield Things CTA	0601104A / AB7
01	0601104A / H04: HBCU/MI Programs	0601104A / AB4

01	0601104A / H05: Institute For Collaborative Biotechnologies	0601104A / AB7 & AB4
01	0601104A / H59: International Tech Centers	0601104A / AC6
01	0601104A / H73: Automotive Research Center (ARC)	0601104A / AB4
01	0601104A / J08: Institute For Creative Technologies (ICT)	0601104A / AB4
01	0601104A / J12: Institute For Soldier Nanotechnology (ISN)	0601104A / AB4
01	0601104A / J14: Army Educational Outreach Program	0601104A / AB8
01	0601104A / J15: Network Sciences ITA	0601104A / AB7
01	0601104A / J17: Vertical Lift Research Center Of Excellence	0601104A / AB4
01	0601104A / VS2: Multi-Scale Materials Modeling Centers	0601104A / AB7
01	0601104A / VS3: Center For Quantum Science Research	0601104A / AB7
02	0602105A / H84: Materials	0602141A / AH8, 0602143A / AZ5 & BE6, 0602145A / BI4
02	0602105A / XW4: Manufacturing Science	0602144A / BL1
02	0602120A / H16: S3I Technology	0602145A / BI2, 0602146A / AP5 & AR1, 0602148A / AL8, 0602150A / AD5
02	0602120A / TS1: Tactical Space Research	0602146A / AO5
02	0602120A / TS2: Robotics Technology	0602145A / BF8
02	0602211A / 47A: AERON & ACFT Wpns Tech	0602148A / AJ6, AJ4, AJ8, AM2, AI7, AK2, AL2, AI5, AJ2, AK1
02	0602211A / 47B: Veh Prop & Struct Tech	0602148A / AK9, AL5, AI9, AL4
02	0602270A / 906: Tactical Electronic Warfare Applied Research	0602146A / AN7, AO2, 0602148A / AK2
02	0602270A / CYB: Applied Offensive Cyber	0602146A / AQ3
02	0602303A / 214: Missile Technology	0602147A / AF8, AF3, AG2, AE7, AG1, AG9, AF9, AF5, AH2, AF6, AF7, 0602148A / AK4, 0602150A / AD3, AD7
02	0602307A / 042: High Energy Laser Technology	0602150A / AC9
02	0602308A / C90: Advanced Distributed Simulation	0602143A / BC3, BE8, 0602145A / BF6
02	0602308A / D02: Modeling & Simulation For Training And Design	0602143A / BE8
02	0602601A / C05: Armor Applied Research	0602145A / BG6, BH9
02	0602601A / H77: National Automotive Center	0602145A / BJ3, BI9
02	0602601A / H91: Ground Vehicle Technology	0602145A / BF1, BF3, BF6, BH7, BH5
02	0602618A / H80: Survivability And Lethality Technology	0602141A / AH5, AH6, AH7, 0602143A / AY6, 0602145A / BG6, 0602147A / AH4
02	0602622A / 552: Smoke/Novel Effect Mun	0602144A / BL2, 0602145A / BG8

02	0602623A / H21: Jt Svc Sa Prog (JSSAP)	0602143A / AY6
02	0602624A / H18: Weapons & Munitions Technologies	0602147A / AG6, AG4, BN4, 0602148A / AK6
02	0602624A / H28: Warheads/Energetics Technologies	0602145A / AH9, 0602147A / AG8, AG6, 0602148A / AK2
02	0602705A / EM8: High Power And Energy Component Technology	0602145A / BH7, 0602146A / AP4, AO2, 0602150A / AD2
02	0602705A / H11: Tactical And Component Power Technology	0602143A / BD8, 0602148A / AM4
02	0602705A / H94: Elec & Electronic Dev	0602144A / BL1, 0602146A / AV9, AO4, AV5, 0602148A / AK2
02	0602709A / H95: Night Vision And Electro-Optic Technology	0602143A / BD1, 0602145A / BH2, BF9, BJ2, 0602148A / AK2
02	0602712A / H24: Countermine Tech	0602143A / BD1, 0602144A / BL4, 0602145A / BJ7
02	0602712A / H35: Camouflage & Counter-Recon Tech	0602145A / BI2
02	0602716A / H70: Human Fact Eng Sys Dev	0602143A / AY6, BB7, BC3, BE8, 0602145A / BF6
02	0602720A / 048: Ind Oper Poll Ctrl Tec	0602144A / BK7
02	0602720A / 835: Mil Med Environ Crit	0602146A / AR5
02	0602720A / 896: Base Fac Environ Qual	0602146A / AR5
02	0602782A / 779: Command, Control And Platform Electronics Tech	0602146A / AV6, AW1, AQ9, AW3, AW5
02	0602782A / CY2: Applied Defensive Cyber	0602146A / AP1, AO8
02	0602782A / H92: Communications Technology	0602143A / AN1, 0602146A / AP7, AM6, AN3, AM8, AN5, AO2, AN9
02	0602783A / Y10: Computer/Info Sci Tech	0602146A / AP3
02	0602784A / 855: Topographical, Image Intel & Space	0602146A / AU5, AU3, AT7, AT9
02	0602784A / H71: Meteorological Research For Battle Command	0602146A / AV7
02	0602784A / T40: Mob/Wpns Eff Tech	0602144A / BL7, BL9, 0602145A / BF1, BG2, 0602146A / AR9, AT2, 0602150A / AE2
02	0602784A / T41: Mil Facilities Eng Tec	0602144A / BK7
02	0602784A / T42: Terrestrial Science Applied Research	0602146A / AT7
02	0602784A / T45: Energy Tec Apl Mil Fac	0602144A / BK7
02	0602786A / H98: Clothing & Equipm Tech	0602143A / AZ2, AZ9, BB4, BB5, BB9, BC2, BC6, BD6
02	0602786A / H99: Joint Service Combat Feeding Technology	0602143A / BE3
02	0602786A / XW5: Small Unit Expeditionary Maneuver Technology	0602143A / BE1, BE3, BR9
02	0602787A / 869: Warfighter Health Prot & Perf Stnds	0602787A / MK4
02	0602787A / 870: Dod Med Def Ag Inf Dis	0602787A / MM8
02	0602787A / 874: Cbt Casualty Care Tech	0602787A / MM4

02	0602787A / ET4: Appl Resch in Clinical and Rehabilitative Medicine	0602787A / MN1
02	0602787A / XV5: Medical Capabilities to Support Dispersed Ops	0602787A / MM6
03	0603001A / 242: Airdrop Equipment	0603118A / BE5
03	0603001A / C07: Joint Service Combat Feeding Tech Demo	0603118A / BE2
03	0603001A / FF6: Individual Protection	0603118A / AY9, AZ6, AZ8, BB3
03	0603001A / J50: Future Warrior Technology Integration	0603118A / BB6, BC1, BC4, BD7, BD9, BB8
03	0603001A / XW6: Small Unit Expeditionary Maneuver	0603118A / BE5
03	0603002A / 810: Ind Base Id Vacc&Drug	0603002A / MN8, MM9, MO9
03	0603002A / 840: Combat Injury Mgmt	0603002A / MO4, MN3, MO7, MN5, MM5, MO2
03	0603002A / MM3: Warfighter Medical Protection & Performance	0603002A / MN6, MO8, MN9, MO3, MN7, MG4
03	0603003A / 313: Adv Rotarywing Veh Tech	0603465A / AI4, AI6, AJ3, AJ5, AJ9, AK3, AK8, AL6 AL9, & AM3
03	0603003A / 436: Rotarywing MEP Integ	0603465A / AL1
03	0603003A / 447: ACFT Demo Engines	0603465A / AI8 & AJ1
03	0603004A / 232: Advanced Lethality & Survivability Demo	0603118A / AY7, 0603462A / BF5, BG5, BI1, BK4, BK6, 0603464A / AE6, AG3, AG5, AG7, 0603465A / AK7
03	0603004A / L96: High Energy Laser Technology Demo	0603466A / AD1
03	0603004A / L97: Smoke And Obscurants Advanced Technology	0603119A / BL3, 0603462A / BG7, BG9
03	0603005A / 221: Combat Veh Survivably	0603462A / BG7, BH1, BI1, BI5
03	0603005A / 441: Combat Vehicle Mobilty	0603119A / BK9, 0603462A / BF7, BG4, BH6, BI8, BJ1, BJ6
03	0603005A / 497: Combat Vehicle Electro	0603462A / BH8
03	0603005A / 515: Robotic Ground Systems	0603462A / BF2, BF4, BK1
03	0603006A / 592: Space Application Tech	0603463A / AO6
03	0603015A / S29: Modeling & Simulation - Adv Tech Dev	0603118A / BC8, BE9
03	0603015A / S31: Modeling And Simulation Infrastructure Technology	0603118A / BC4, BC8, BE9
03	0603125A / DF5: Agile Integration & Demonstration	0602145A / BH5, BI4
03	0603125A / DW4: Energy Technologies (Congressional Adds (CAs))	0602145A / BH5, BI4
03	0603270A / CY3: Offensive Cyber Operations Mirror Adv Tech	0603463A / AQ4
03	0603270A / K15: Advanced Comm Ecm Demo	0603463A / AN8, AO7, AO3, AO1
03	0603270A / K16: Non-Commo Ecm Tech Dem	0603465A / AK3, 0603462A / BG7, 0603463A / AO1
03	0603313A / 206: Missile Simulation	0603464A / AF4

03	0603313A / 263: Future Msl Tech Integr(FMTI)	0603464A / AE8, AE9, AH3, BS3, 0603462A / BG7
03	0603313A / 704: Advanced Missile Demo	0603466A / AC8 & AD4, 0603465A / AK5
03	0603606A / 608: Countermine & Bar Dev	0603118A / BC9, 0603462A / BJ8
03	0603606A / 683: Area Denial Sensors	0603462A / BG1
03	0603607A / 627: Jt Svc Sa Prog (JSSAP)	0603118A / AY5
03	0603710A / K70: Night Vision Adv Tech	0603118A / BC9, 0603462A / BI3, BG1, 0603463A / AQ5
03	0603710A / K86: Night Vision, Abn Sys	0603465A / AK3, AL6, AL7
03	0603728A / 002: Environmental Compliance Technology	0603119A / BK8
03	0603728A / 03E: Environmental Restoration Technology	0603119A / BM1, 0603463A / AR4, AR6
03	0603734A / T08: Combat Eng Systems	0603119A / BL6, BL8, BM1, 0603462A / BG3, 0603463A / AS9, AU6, AU4, AT8, AT3, AU1, 0603466A / AE3
03	0603772A / 101: Tactical Command and Control	0603462A / BH3, 0603463A / AW2, AW4, AR2, AV8
03	0603772A / 243: Sensors And Signals Processing	0603466A / AD6
03	0603794A / EL4: Tactical Comms and Networking Technology Int	0603463A / AP6, AP8, AM7, AP9, AN4, AN6, AO3, AQ1, AO1
03	0603794A / EL5: Secure Tactical Information Integration	0603463A / AP2, AO9
04	0603774A / VT7: Soldier Maneuver Sensors - Adv Dev	0603774A / BQ5
04	0604120A / ED5: Assured Positioning, Navigation and Timing (PNT)	1206120A / FJ8
04	0604120A / EH8: DISMOUNTED	1206120A / FJ9
04	0604120A / EH9: PSEUDOLITES	1206120A / FK1
04	0604120A / EJ2: MOUNTED	1206120A / FK2
04	0604120A / EJ3: ANTI-JAM ANTENNA	1206120A / FK3
04	0604319A / DU3: IFPC2	0605052A / EY7
05	0604710A / L67: Soldier Night Vision Devices	0604710A / BQ6
05	0604798A / FG7: Emerging Technology Initiatives	0605054A / FI3
05	0605013A / 738: AcqBiz	0605013A / FL9
05	0605053A / FB8: Soldier Borne Sensor (SBS)	0604827A / FK4
06	0604256A / 976: Army Threat Sim (ATS)	0604759A / FF1
07	0205402A / EF2: Integrated Base Defense	0604785A / DS4

Program Terminations:

<u>Budget Activity</u>	<u>OSDPE / Project</u>	<u>OSDPE Title / Project Title</u>
01	0601103A / V72	University Research Initiatives / Minerva
01	0601104A / H09	University and Industry Research Centers / Robotics CTA
01	0601104A / H50	University and Industry Research Centers / Network Sciences Cta
02	0602105A / H7G	Materials Technology / Nanomaterials Applied Research
02	0602120A / SA2	Sensors and Electronic Survivability / Biotechnology Applied Research
02	0602624A / H19	Weapons and Munitions Technology / Asymmetric & Counter Measure Technologies
02	0602705A / H17	Electronics and Electronic Devices / Flexible Display Center
02	0602720A / 895	Environmental Quality Technology / Pollution Prevention
02	0602786A / 283	Warfighter Technology / Airdrop Adv Tech
02	0602786A / VT4	Warfighter Technology / Expeditionary Mobile Base Camp Technology
03	0603001A / 543	Warfighter Advanced Technology / Ammunition Logistics
03	0603001A / VT5	Warfighter Advanced Technology / Expeditionary Mobile Base Camp Demonstration
03	0603002A / ET5	Medical Advanced Technology / Adv Tech Dev in Clinical & Rehabilitative Medicine
03	0603728A / 025	Environmental Quality Technology Demonstrations / Pollution Prevention Technology
04	0603619A / 606	Landmine Warfare and Barrier - Adv Dev / Cntrmn/Barrier Adv Dev
04	0603639A / EL8	Tank and Medium Caliber Ammunition / LIGHTWEIGHT CARTRIDGE CASE FOR SMALL CALIBER
04	0603804A / EW8	Logistics and Engineer Equipment - Adv Dev / Armored Engineer Vehicles
04	0603804A / K39	Logistics and Engineer Equipment - Adv Dev / Field Sustainment Support Ad
04	0603804A / K41	Logistics and Engineer Equipment - Adv Dev / Water And Petroleum Distribution - Ad
04	0603804A / VR8	Logistics and Engineer Equipment - Adv Dev / Combat Service Support Systems - Ad
04	0604020A / CF1	Cross Functional Team (CFT) Advanced Development & Prototyping / CFT Advanced Development & Prototyping
04	0604115A / DS3	Technology Maturation Initiatives / Technology Maturation Initiatives
04	1206308A / FE6	Army Space Systems Integration / Army Space System Enhancement/Integration
05	0210609A / ED8	Paladin Integrated Management (PIM) / Paladin Integrated Management (PIM)
05	0604321A / B41	All Source Analysis System / CI/HUMINT Software Products (MIP)
05	0604321A / B51	All Source Analysis System / Machine - Foreign Language Translation System
05	0604601A / S62	Infantry Support Weapons / Counter-Defilade Target Engagement - SDD

05	0604601A / S70	Infantry Support Weapons / Personnel Recovery Support System (PRSS)
05	0604622A / E50	Family of Heavy Tactical Vehicles / TRAILER DEVELOPMENT
05	0604713A / EL2	Combat Feeding, Clothing, and Equipment / Army Field Feeding Equipment
05	0604741A / FG5	Air Defense Command, Control and Intelligence - Eng Dev / Counter Unmanned Aerial Systems (UAS)
05	0604768A / P01	Brilliant Anti-Armor Submunition (BAT) / MULTI - MODE SEEKER DEVELOPMENT AND TEST
05	0604780A / 571	Combined Arms Tactical Trainer (CATT) Core / Close Cbt Tact Trainer
05	0604780A / 577	Combined Arms Tactical Trainer (CATT) Core / Gaming Technology In Support Of Army Training
05	0604780A / 585	Combined Arms Tactical Trainer (CATT) Core / Aviation Combined Arms Tactical Trainer
05	0604804A / EC9	Logistics and Engineer Equipment - Eng Dev / Contingency Basing Infrastructure
05	0604804A / H01	Logistics and Engineer Equipment - Eng Dev / Combat Engineer Eq Ed
05	0604804A / H14	Logistics and Engineer Equipment - Eng Dev / Materials Handling Equipment - Ed
05	0604804A / VR7	Logistics and Engineer Equipment - Eng Dev / Combat Service Support Systems
05	0604818A / 334	Army Tactical Command & Control Hardware & Software / Common Software
05	0604823A / L87	Firefinder / Hypervelocity Armament System (HAS)
05	0604827A / EY3	Soldier Systems - Warrior Dem/Val / Soldier Power Generator
05	0605013A / FE9	Information Technology Development / ALTESS (P&R Forms)
05	0605029A / EQ2	Integrated Ground Security Surveillance Response Capability (IGSSR-C) / IntegGrdSecSurvRespC(IGSSR-C)
05	0605037A / EQ6	Evidence Collection and Detainee Processing / Evidence Collection and Detainee Processing
05	0605380A / EG6	AMF Joint Tactical Radio System (JTRS) / Small Airborne Networking Radio (SANR)
06	0303260A / FA9	Defense Military Deception Initiative / Security Initiatives
06	0604759A / 986	Major T&E Investment / Major Operational Test Instrumentation
06	0604759A / FA4	Major T&E Investment / Warrior Injury Assessment Manikin (WIAMan)
06	0605803A / 720	Technical Information Activities / Tech Info Func Actv
06	0605803A / 730	Technical Information Activities / Pers & Trng Analys Act
06	0605803A / C16	Technical Information Activities / FAST
06	0605803A / C18	Technical Information Activities / BAST
07	0203735A / 431	Combat Vehicle Improvement Programs / M113 IMPROVEMENTS
07	0203735A / FD8	Combat Vehicle Improvement Programs / Light Armored Vehicle Improvement
07	0203740A / 484	Maneuver Control System / Maneuver Control System
07	0203801A / DT5	Missile/Air Defense Product Improvement Program / Stinger Product Improvement

07	0203802A / 788	Other Missile Product Improvement Programs / ATACMS PIP
07	0205410A / EE9	Materials Handling Equipment / Material Handling Equipment - Advance Development
07	0303140A / FF8	Information Systems Security Program / Unit Activity Monitoring (UAM)
07	0303150A / EA5	WWMCCS/Global Command and Control System / Strategic and Joint Mission Command
07	0305219A / MQ1	MQ-1 Gray Eagle UAV / MQ-1 Gray Eagle - Army UAV (MIP)
07	0607135A / ES2	Apache Product Improvement Program / Apache Product Improvement Program
07	0607140A / ES7	Emerging Technologies from NIE / Emerging Technologies from NIE
07	0607665A / DT2	Family of Biometrics / 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 (ASA(ALT)) Special Programs Office.

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Department of Defense
 FY 2020 President's Budget
 Exhibit R-1 FY 2020 President's Budget
 Total Obligational Authority
 (Dollars in Thousands)

12 Feb 2019

<u>Appropriation</u>	<u>FY 2018</u> <u>(Base + OCO)</u>	<u>FY 2019</u> <u>Base Enacted</u>	<u>FY 2019</u> <u>OCO Enacted</u>	<u>FY 2019</u> <u>Total Enacted</u>
Research, Development, Test & Eval, Army	11,633,461	11,074,556	300,604	11,375,160
Total Research, Development, Test & Evaluation	11,633,461	11,074,556	300,604	11,375,160

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Appropriation	FY 2020 Base	FY 2020 OCO for Base Requirements	FY 2020 OCO for Direct War and Enduring Costs	FY 2020 Total OCO	FY 2020 Total (Base + OCO)
Research, Development, Test & Eval, Army	12,192,771		204,124	204,124	12,396,895
Total Research, Development, Test & Evaluation	12,192,771		204,124	204,124	12,396,895

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<u>Summary Recap of Budget Activities</u>	<u>FY 2018 (Base + OCO)</u>	<u>FY 2019 Base Enacted</u>	<u>FY 2019 OCO Enacted</u>	<u>FY 2019 Total Enacted</u>
Basic Research	464,187	506,444		506,444
Applied Research	1,342,832	1,578,725		1,578,725
Advanced Technology Development	1,503,959	1,585,778		1,585,778
Advanced Component Development & Prototypes	1,563,615	1,264,647	4,000	1,268,647
System Development & Demonstration	3,349,488	2,965,361	236,863	3,202,224
RDT&E Management Support	1,579,102	1,438,536		1,438,536
Operational Systems Development	1,830,278	1,735,065	59,741	1,794,806
Total Research, Development, Test & Evaluation	11,633,461	11,074,556	300,604	11,375,160
<u>Summary Recap of FYDP Programs</u>				
General Purpose Forces	668,082	666,757	10,000	676,757
Intelligence and Communications	401,118	252,771	40,613	293,384
Research and Development	10,369,821	9,830,755	249,991	10,080,746
Central Supply and Maintenance	118,410	108,696		108,696
Administration and Associated Activities	654			
Space	68,222	209,622		209,622
Classified Programs	7,154	5,955		5,955
Total Research, Development, Test & Evaluation	11,633,461	11,074,556	300,604	11,375,160

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	FY 2020 Base	FY 2020 OCO for Base Requirements	FY 2020 OCO for Direct War and Enduring Costs	FY 2020 Total OCO	FY 2020 Total (Base + OCO)
<u>Summary Recap of Budget Activities</u>					
Basic Research	454,980				454,980
Applied Research	893,990				893,990
Advanced Technology Development	1,099,564				1,099,564
Advanced Component Development & Prototypes	2,929,355		17,114	17,114	2,946,469
System Development & Demonstration	3,549,431		111,917	111,917	3,661,348
RDT&E Management Support	1,286,625		1,875	1,875	1,288,500
Operational Systems Development	1,978,826		73,218	73,218	2,052,044
Total Research; Development, Test & Evaluation	12,192,771		204,124	204,124	12,396,895
<u>Summary Recap of FYDP Programs</u>					
General Purpose Forces	866,366				866,366
Intelligence and Communications	257,681		76,418	76,418	334,099
Research and Development	10,659,601		127,706	127,706	10,787,307
Central Supply and Maintenance	59,848				59,848
Administration and Associated Activities					
Space	342,002				342,002
Classified Programs	7,273				7,273
Total Research, Development, Test & Evaluation	12,192,771		204,124	204,124	12,396,895

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<u>Summary Recap of Budget Activities</u>	<u>FY 2018 (Base + OCO)</u>	<u>FY 2019 Base Enacted</u>	<u>FY 2019 OCO Enacted</u>	<u>FY 2019 Total Enacted</u>
Basic Research	464,187	506,444		506,444
Applied Research	1,342,832	1,578,725		1,578,725
Advanced Technology Development	1,503,959	1,585,778		1,585,778
Advanced Component Development & Prototypes	1,563,615	1,264,647	4,000	1,268,647
System Development & Demonstration	3,349,488	2,965,361	236,863	3,202,224
RDT&E Management Support	1,579,102	1,438,536		1,438,536
Operational Systems Development	1,830,278	1,735,065	59,741	1,794,806
Total Research, Development, Test & Evaluation	11,633,461	11,074,556	300,604	11,375,160
<u>Summary Recap of FYDP Programs</u>				
General Purpose Forces	668,082	666,757	10,000	676,757
Intelligence and Communications	401,118	252,771	40,613	293,384
Research and Development	10,369,821	9,830,755	249,991	10,080,746
Central Supply and Maintenance	118,410	108,696		108,696
Administration and Associated Activities	654			
Space	68,222	209,622		209,622
Classified Programs	7,154	5,955		5,955
Total Research, Development, Test & Evaluation	11,633,461	11,074,556	300,604	11,375,160

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	FY 2020 Base	FY 2020 OCO for Base Requirements	FY 2020 OCO for Direct War and Enduring Costs	FY 2020 Total OCO	FY 2020 Total (Base + OCO)
<u>Summary Recap of Budget Activities</u>					
Basic Research	454,980				454,980
Applied Research	893,990				893,990
Advanced Technology Development	1,099,564				1,099,564
Advanced Component Development & Prototypes	2,929,355		17,114	17,114	2,946,469
System Development & Demonstration	3,549,431		111,917	111,917	3,661,348
RDT&E Management Support	1,286,625		1,875	1,875	1,288,500
Operational Systems Development	1,978,826		73,218	73,218	2,052,044
Total Research, Development, Test & Evaluation	12,192,771		204,124	204,124	12,396,895
<u>Summary Recap of FYDP Programs</u>					
General Purpose Forces	866,366				866,366
Intelligence and Communications	257,681		76,418	76,418	334,099
Research and Development	10,659,601		127,706	127,706	10,787,307
Central Supply and Maintenance	59,848				59,848
Administration and Associated Activities					
Space	342,002				342,002
Classified Programs	7,273				7,273
Total Research, Development, Test & Evaluation	12,192,771		204,124	204,124	12,396,895

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Line No	Program Element Number	Item	Act	FY 2018 (Base + OCO)	FY 2019 Base Enacted	FY 2019 OCO Enacted	FY 2019 Total Enacted	Se
1	0601101A	In-House Laboratory Independent Research	01	11,783	11,579		11,579	U
2	0601102A	Defense Research Sciences	01	274,098	315,660		315,660	U
3	0601103A	University Research Initiatives	01	74,349	65,202		65,202	U
4	0601104A	University and Industry Research Centers	01	103,957	114,003		114,003	U
5	0601121A	Cyber Collaborative Research Alliance	01					U
		Basic Research		464,187	506,444		506,444	
6	0602105A	Materials Technology	02	73,136	83,586		83,586	U
7	0602120A	Sensors and Electronic Survivability	02	83,581	80,849		80,849	U
8	0602122A	TRACTOR HIP	02	8,627	8,674		8,674	U
9	0602126A	TRACTOR JACK	02		400		400	U
10	0602141A	Lethality Technology	02					U
11	0602142A	Army Applied Research	02					U
12	0602143A	Soldier Lethality Technology	02					U
13	0602144A	Ground Technology	02					U
14	0602145A	Next Generation Combat Vehicle Technology	02					U
15	0602146A	Network C3I Technology	02					U
16	0602147A	Long Range Precision Fires Technology	02					U
17	0602148A	Future Verticle Lift Technology	02					U

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Line No	Program Element Number	Item	Act	FY 2020 Base	FY 2020 OCO for Base Requirements	FY 2020 OCO for Direct War and Enduring Costs	FY 2020 Total OCO	FY 2020 Total (Base + OCO)	Se
1	0601101A	In-House Laboratory Research	01						U
2	0601102A	Defense Research Sciences	01	297,976				297,976	U
3	0601103A	University Research Initiatives	01	65,858				65,858	U
4	0601104A	University and Industry Research Centers	01	86,164				86,164	U
5	0601121A	Cyber Collaborative Research Alliance	01	4,982				4,982	U
		Basic Research		454,980				454,980	
6	0602105A	Materials Technology	02						U
7	0602120A	Sensors and Electronic Survivability	02						U
8	0602122A	TRACTOR HIP	02						U
9	0602126A	TRACTOR JACK	02						U
10	0602141A	Lethality Technology	02	26,961				26,961	U
11	0602142A	Army Applied Research	02	25,319				25,319	U
12	0602143A	Soldier Lethality Technology	02	115,274				115,274	U
13	0602144A	Ground Technology	02	35,199				35,199	U
14	0602145A	Next Generation Combat Vehicle Technology	02	219,047				219,047	U
15	0602146A	Network C3I Technology	02	114,516				114,516	U
16	0602147A	Long Range Precision Fires Technology	02	74,327				74,327	U
17	0602148A	Future Verticle Lift Technology	02	93,601				93,601	U

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18	0602150A	Air and Missile Defense Technology	02					U
19	0602211A	Aviation Technology	02	72,170	81,805		81,805	U
20	0602213A	C3I Applied Cyber	02					U
21	0602270A	Electronic Warfare Technology	02	33,683	25,558		25,558	U
22	0602303A	Missile Technology	02	52,858	91,647		91,647	U
23	0602307A	Advanced Weapons Technology	02	36,959	44,468		44,468	U
24	0602308A	Advanced Concepts and Simulation	02	27,662	28,470		28,470	U
25	0602601A	Combat Vehicle and Automotive Technology	02	78,759	104,404		104,404	U
26	0602618A	Ballistics Technology	02	83,299	85,491		85,491	U
27	0602622A	Chemical, Smoke and Equipment Defeating Technology	02	3,895	5,027		5,027	U
28	0602623A	Joint Service Small Arms Program	02	6,473	12,380		12,380	U
29	0602624A	Weapons and Munitions Technology	02	241,344	383,410		383,410	U
30	0602705A	Electronics and Electronic Devices	02	90,613	96,760		96,760	U
31	0602709A	Night Vision Technology	02	38,243	33,573		33,573	U
32	0602712A	Countermine Systems	02	25,329	27,223		27,223	U
33	0602716A	Human Factors Engineering Technology	02	23,813	24,121		24,121	U
34	0602720A	Environmental Quality Technology	02	34,118	19,469		19,469	U
35	0602782A	Command, Control, Communications Technology	02	32,458	54,956		54,956	U
36	0602783A	Computer and Software Technology	02	13,707	14,948		14,948	U

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18	0602150A	Air and Missile Defense Technology	02	50,771				50,771	U
19	0602211A	Aviation Technology	02						U
20	0602213A	C3I Applied Cyber	02	18,947				18,947	U
21	0602270A	Electronic Warfare Technology	02						U
22	0602303A	Missile Technology	02						U
23	0602307A	Advanced Weapons Technology	02						U
24	0602308A	Advanced Concepts and Simulation	02						U
25	0602601A	Combat Vehicle and Automotive Technology	02						U
26	0602618A	Ballistics Technology	02						U
27	0602622A	Chemical, Smoke and Equipment Defeating Technology	02						U
28	0602623A	Joint Service Small Arms Program	02						U
29	0602624A	Weapons and Munitions Technology	02						U
30	0602705A	Electronics and Electronic Devices	02						U
31	0602709A	Night Vision Technology	02						U
32	0602712A	Countermine Systems	02						U
33	0602716A	Human Factors Engineering Technology	02						U
34	0602720A	Environmental Quality Technology	02						U
35	0602782A	Command, Control, Communications Technology	02						U
36	0602783A	Computer and Software Technology	02						U

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37	0602784A	Military Engineering Technology	02	114,947	101,124		101,124	U
38	0602785A	Manpower/Personnel/Training Technology	02	19,791	21,847		21,847	U
39	0602786A	Warfighter Technology	02	58,476	56,532		56,532	U
40	0602787A	Medical Technology	02	88,891	92,003		92,003	U
		Applied Research		1,342,832	1,578,725		1,578,725	
41	0603001A	Warfighter Advanced Technology	03	53,763	41,795		41,795	U
42	0603002A	Medical Advanced Technology	03	103,908	101,442		101,442	U
43	0603003A	Aviation Advanced Technology	03	172,545	169,411		169,411	U
44	0603004A	Weapons and Munitions Advanced Technology	03	195,345	241,581		241,581	U
45	0603005A	Combat Vehicle and Automotive Advanced Technology	03	154,084	176,622		176,622	U
46	0603006A	Space Application Advanced Technology	03	39,277	48,985		48,985	U
47	0603007A	Manpower, Personnel and Training Advanced Technology	03	5,063	8,038		8,038	U
48	0603009A	TRACTOR HIKE	03	39,302	22,631		22,631	U
49	0603015A	Next Generation Training & Simulation Systems	03	15,778	28,650		28,650	U
50	0603117A	Army Advanced Technology Development	03					U
51	0603118A	Soldier Lethality Advanced Technology	03					U
52	0603119A	Ground Advanced Technology	03					U

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Line No	Program Element Number	Item	Act	FY 2020 Base	FY 2020 OCO for Base Requirements	FY 2020 OCO for Direct War and Enduring Costs	FY 2020 Total OCO	FY 2020 Total (Base + OCO)	Se c
37	0602784A	Military Engineering Technology	02						U
38	0602785A	Manpower/Personnel/Training Technology	02	20,873				20,873	U
39	0602786A	Warfighter Technology	02						U
40	0602787A	Medical Technology	02	99,155				99,155	U
		Applied Research		893,990				893,990	
41	0603001A	Warfighter Advanced Technology	03						U
42	0603002A	Medical Advanced Technology	03	42,030				42,030	U
43	0603003A	Aviation Advanced Technology	03						U
44	0603004A	Weapons and Munitions Advanced Technology	03						U
45	0603005A	Combat Vehicle and Automotive Advanced Technology	03						U
46	0603006A	Space Application Advanced Technology	03						U
47	0603007A	Manpower, Personnel and Training Advanced Technology	03	11,038				11,038	U
48	0603009A	TRACTOR HIKE	03						U
49	0603015A	Next Generation Training & Simulation Systems	03						U
50	0603117A	Army Advanced Technology Development	03	63,338				63,338	U
51	0603118A	Soldier Lethality Advanced Technology	03	118,468				118,468	U
52	0603119A	Ground Advanced Technology	03	12,593				12,593	U

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Line No	Program Element Number	Item	Act	FY 2018 (Base + OCO)	FY 2019 Base Enacted	FY 2019 OCO Enacted	FY 2019 Total Enacted	Se c
53	0603125A	Combating Terrorism - Technology Development	03	44,088	36,757		36,757	U
54	0603130A	TRACTOR NAIL	03	4,880	4,896		4,896	U
55	0603131A	TRACTOR EGGS	03	4,326	6,041		6,041	U
56	0603270A	Electronic Warfare Technology	03	33,249	41,458		41,458	U
57	0603313A	Missile and Rocket Advanced Technology	03	133,433	94,561		94,561	U
58	0603322A	TRACTOR CAGE	03	12,323	16,845		16,845	U
59	0603457A	C3I Cyber Advanced Development	03					U
60	0603461A	High Performance Computing Modernization Program	03	214,100	218,098		218,098	U
61	0603462A	Next Generation Combat Vehicle Advanced Technology	03					U
62	0603463A	Network C3I Advanced Technology	03					U
63	0603464A	Long Range Precision Fires Advanced Technology	03					U
64	0603465A	Future Vertical Lift Advanced Technology	03					U
65	0603466A	Air and Missile Defense Advanced Technology	03					U
66	0603606A	Landmine Warfare and Barrier Advanced Technology	03	18,473	17,097		17,097	U
67	0603607A	Joint Service Small Arms Program	03	5,628	22,799		22,799	U
68	0603710A	Night Vision Advanced Technology	03	45,617	61,313		61,313	U

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Line No	Program Element Number	Item	Act	FY 2020 Base	FY 2020 OCO for Base Requirements	FY 2020 OCO for Direct War and Enduring Costs	FY 2020 Total OCO	FY 2020 Total (Base + OCO)	Se
53	0603125A	Combating Terrorism - Technology Development	03						U
54	0603130A	TRACTOR NAIL	03						U
55	0603131A	TRACTOR EGGS	03						U
56	0603270A	Electronic Warfare Technology	03						U
57	0603313A	Missile and Rocket Advanced Technology	03						U
58	0603322A	TRACTOR CAGE	03						U
59	0603457A	C3I Cyber Advanced Development	03	13,769				13,769	U
60	0603461A	High Performance Computing Modernization Program	03	184,755				184,755	U
61	0603462A	Next Generation Combat Vehicle Advanced Technology	03	160,035				160,035	U
62	0603463A	Network C3I Advanced Technology	03	106,899				106,899	U
63	0603464A	Long Range Precision Fires Advanced Technology	03	174,386				174,386	U
64	0603465A	Future Vertical Lift Advanced Technology	03	151,640				151,640	U
65	0603466A	Air and Missile Defense Advanced Technology	03	60,613				60,613	U
66	0603606A	Landmine Warfare and Barrier Advanced Technology	03						U
67	0603607A	Joint Service Small Arms Program	03						U
68	0603710A	Night Vision Advanced Technology	03						U

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Line No	Program Element Number	Item	Act	FY 2018 (Base + OCO)	FY 2019 Base Enacted	FY 2019 OCO Enacted	FY 2019 Total Enacted	S e c
69	0603728A	Environmental Quality Technology Demonstrations	03	29,150	29,132		29,132	U
70	0603734A	Military Engineering Advanced Technology	03	96,586	101,438		101,438	U
71	0603772A	Advanced Tactical Computer Science and Sensor Technology	03	50,637	43,856		43,856	U
72	0603794A	C3 Advanced Technology	03	32,404	52,332		52,332	U
		Advanced Technology Development		1,503,959	1,585,778		1,585,778	
73	0603305A	Army Missile Defense Systems Integration	04	23,558	60,472		60,472	U
74	0603327A	Air and Missile Defense Systems Engineering	04	58,812	45,231	1,000	46,231	U
75	0603619A	Landmine Warfare and Barrier - Adv Dev	04	69,237	45,198		45,198	U
76	0603627A	Smoke, Obscurant and Target Defeating Sys-Adv Dev	04	8,920	20,674		20,674	U
77	0603639A	Tank and Medium Caliber Ammunition	04	45,448	41,921		41,921	U
78	0603645A	Armored System Modernization - Adv Dev	04	41,431	84,297		84,297	U
79	0603747A	Soldier Support and Survivability	04	15,759	8,735	3,000	11,735	U
80	0603766A	Tactical Electronic Surveillance System - Adv Dev	04	27,733	35,667		35,667	U
81	0603774A	Night Vision Systems Advanced Development	04	501,816	7,341		7,341	U
82	0603779A	Environmental Quality Technology - Dem/Val	04	15,039	14,731		14,731	U

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Line No	Program Element Number	Item	Act	FY 2020 Base	FY 2020 OCO for Base Requirements	FY 2020 OCO for Direct War and Enduring Costs	FY 2020 Total OCO	FY 2020 Total (Base + OCO)	Se
69	0603728A	Environmental Quality Technology Demonstrations	03						U
70	0603734A	Military Engineering Advanced Technology	03						U
71	0603772A	Advanced Tactical Computer Science and Sensor Technology	03						U
72	0603794A	C3 Advanced Technology	03						U
		Advanced Technology Development		1,099,564				1,099,564	
73	0603305A	Army Missile Defense Systems Integration	04	10,987				10,987	U
74	0603327A	Air and Missile Defense Systems Engineering	04	15,148		500	500	15,648	U
75	0603619A	Landmine Warfare and Barrier - Adv Dev	04	92,915				92,915	U
76	0603627A	Smoke, Obscurant and Target Defeating Sys-Adv Dev	04						U
77	0603639A	Tank and Medium Caliber Ammunition	04	82,146				82,146	U
78	0603645A	Armored System Modernization - Adv Dev	04	157,656				157,656	U
79	0603747A	Soldier Support and Survivability	04	6,514		3,000	3,000	9,514	U
80	0603766A	Tactical Electronic Surveillance System - Adv Dev	04	34,890				34,890	U
81	0603774A	Night Vision Systems Advanced Development	04	251,011				251,011	U
82	0603779A	Environmental Quality Technology - Dem/Val	04	15,132				15,132	U

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83	0603790A	NATO Research and Development	04	2,485	3,682		3,682	U
84	0603801A	Aviation - Adv Dev	04	9,653	86,180		86,180	U
85	0603804A	Logistics and Engineer Equipment - Adv Dev	04	29,619	17,230		17,230	U
86	0603807A	Medical Systems - Adv Dev	04	36,279	39,244		39,244	U
87	0603827A	Soldier Systems - Advanced Development	04	60,774	31,022		31,022	U
88	0604017A	Robotics Development	04	38,051	74,368		74,368	U
89	0604020A	Cross Functional Team (CFT) Advanced Development & Prototyping	04		9,488		9,488	U
90	0604021A	Electronic Warfare Technology Maturation (MIP)	04					U
91	0604100A	Analysis Of Alternatives	04	7,307	9,753		9,753	U
92	0604113A	Future Tactical Unmanned Aircraft System (FTUAS)	04		12,393		12,393	U
93	0604114A	Lower Tier Air Missile Defense (LTAMD) Sensor	04	57,437	89,248		89,248	U
94	0604115A	Technology Maturation Initiatives	04	145,618	95,229		95,229	U
95	0604117A	Maneuver - Short Range Air Defense (M-SHORAD)	04	19,201	79,016		79,016	U
96	0604118A	TRACTOR BEAM	04	10,400	52,894		52,894	U
97	0604119A	Army Advanced Component Development & Prototyping	04					U
98	0604120A	Assured Positioning, Navigation and Timing (PNT)	04	132,810				U

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83	0603790A	NATO Research and Development	04	5,406				5,406	U
84	0603801A	Aviation - Adv Dev	04	459,290				459,290	U
85	0603804A	Logistics and Engineer Equipment - Adv Dev	04	6,254		1,085	1,085	7,339	U
86	0603807A	Medical Systems - Adv Dev	04	31,175				31,175	U
87	0603827A	Soldier Systems - Advanced Development	04	22,113				22,113	U
88	0604017A	Robotics Development	04	115,222				115,222	U
89	0604020A	Cross Functional Team (CFT) Advanced Development & Prototyping	04						U
90	0604021A	Electronic Warfare Technology Maturation (MIP)	04	18,043				18,043	U
91	0604100A	Analysis Of Alternatives	04	10,023				10,023	U
92	0604113A	Future Tactical Unmanned Aircraft System (FTUAS)	04	40,745				40,745	U
93	0604114A	Lower Tier Air Missile Defense (LTAMD) Sensor	04	427,772				427,772	U
94	0604115A	Technology Maturation Initiatives	04	196,676				196,676	U
95	0604117A	Maneuver - Short Range Air Defense (M-SHORAD)	04	33,100		6,000	6,000	39,100	U
96	0604118A	TRACTOR BEAM	04						U
97	0604119A	Army Advanced Component Development & Prototyping	04	115,116		4,529	4,529	119,645	U
98	0604120A	Assured Positioning, Navigation and Timing (PNT)	04						U

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99	0604121A	Synthetic Training Environment Refinement & Prototyping	04	109,165	39,890		39,890	U
100	0604182A	Hypersonics	04					U
101	0604319A	Indirect Fire Protection Capability Increment 2-Intercept (IFPC2)	04	10,871	40,979		40,979	U
102	0604403A	Future Interceptor	04					U
103	0604541A	Unified Network Transport	04					U
104	0604644A	Mobile Medium Range Missile	04					U
105	0604785A	Integrated Base Defense (Budget Activity 4)	04					U
106	0305251A	Cyberspace Operations Forces and Force Support	04	56,071	52,817		52,817	U
107	1206120A	Assured Positioning, Navigation and Timing (PNT)	04		128,640		128,640	U
108	1206308A	Army Space Systems Integration	04	30,121	38,307		38,307	U
		Advanced Component Development & Prototypes		1,563,615	1,264,647	4,000	1,268,647	
109	0604201A	Aircraft Avionics	05	30,812	32,253		32,253	U
110	0604270A	Electronic Warfare Development	05	68,935	58,627		58,627	U
111	0604321A	All Source Analysis System	05	4,774				U
112	0604328A	TRACTOR CAGE	05	30,252	17,050	12,000	29,050	U
113	0604601A	Infantry Support Weapons	05	99,145	63,793		63,793	U
114	0604604A	Medium Tactical Vehicles	05	5,798	3,699		3,699	U
115	0604611A	JAVELIN	05	20,252	5,616		5,616	U

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99	0604121A	Synthetic Training Environment Refinement & Prototyping	04	136,761				136,761	U
100	0604182A	Hypersonics	04	228,000				228,000	U
101	0604319A	Indirect Fire Protection Capability Increment 2-Intercept (IFPC2)	04						U
102	0604403A	Future Interceptor	04	8,000				8,000	U
103	0604541A	Unified Network Transport	04	39,600				39,600	U
104	0604644A	Mobile Medium Range Missile	04	20,000				20,000	U
105	0604785A	Integrated Base Defense (Budget Activity 4)	04			2,000	2,000	2,000	U
106	0305251A	Cyberspace Operations Forces and Force Support	04	52,102				52,102	U
107	1206120A	Assured Positioning, Navigation and Timing (PNT)	04	192,562				192,562	U
108	1206308A	Army Space Systems Integration	04	104,996				104,996	U
		Advanced Component Development & Prototypes		2,929,355		17,114	17,114	2,946,469	
109	0604201A	Aircraft Avionics	05	29,164				29,164	U
110	0604270A	Electronic Warfare Development	05	70,539				70,539	U
111	0604321A	All Source Analysis System	05						U
112	0604328A	TRACTOR CAGE	05						U
113	0604601A	Infantry Support Weapons	05	106,121				106,121	U
114	0604604A	Medium Tactical Vehicles	05	2,152				2,152	U
115	0604611A	JAVELIN	05	17,897				17,897	U

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116	0604622A	Family of Heavy Tactical Vehicles	05	10,086	11,935		11,935	U
117	0604633A	Air Traffic Control	05	3,433	12,332		12,332	U
118	0604642A	Light Tactical Wheeled Vehicles	05	3,619	1,276		1,276	U
119	0604645A	Armored Systems Modernization (ASM) - Eng Dev	05	34,794	373,337		373,337	U
120	0604710A	Night Vision Systems - Eng Dev	05	184,389	144,442		144,442	U
121	0604713A	Combat Feeding, Clothing, and Equipment	05	8,561	4,502		4,502	U
122	0604715A	Non-System Training Devices - Eng Dev	05	51,900	44,381		44,381	U
123	0604741A	Air Defense Command, Control and Intelligence - Eng Dev	05	190,385	93,073	119,300	212,373	U
124	0604742A	Constructive Simulation Systems Development	05	17,921	22,600		22,600	U
125	0604746A	Automatic Test Equipment Development	05	7,054	11,782		11,782	U
126	0604760A	Distributive Interactive Simulations (DIS) - Eng Dev	05	10,890	9,134		9,134	U
127	0604768A	Brilliant Anti-Armor Submunition (BAT)	05	7,886	6,886		6,886	U
128	0604780A	Combined Arms Tactical Trainer (CATT) Core	05	17,855	21,936		21,936	U
129	0604798A	Brigade Analysis, Integration and Evaluation	05	139,386	49,250		49,250	U
130	0604802A	Weapons and Munitions - Eng Dev	05	144,389	172,744		172,744	U

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116	0604622A	Family of Heavy Tactical Vehicles	05	16,745			16,745	16,745	U
117	0604633A	Air Traffic Control	05	6,989			6,989	6,989	U
118	0604642A	Light Tactical Wheeled Vehicles	05	10,465			10,465	10,465	U
119	0604645A	Armored Systems Modernization (ASM) - Eng Dev	05	310,152			310,152	310,152	U
120	0604710A	Night Vision Systems - Eng Dev	05	181,732			181,732	181,732	U
121	0604713A	Combat Feeding, Clothing, and Equipment	05	2,393			2,393	2,393	U
122	0604715A	Non-System Training Devices - Eng Dev	05	27,412			27,412	27,412	U
123	0604741A	Air Defense Command, Control and Intelligence - Eng Dev	05	43,502			43,502	43,502	U
124	0604742A	Constructive Simulation Systems Development	05	11,636			11,636	11,636	U
125	0604746A	Automatic Test Equipment Development	05	10,915			10,915	10,915	U
126	0604760A	Distributive Interactive Simulations (DIS) - Eng Dev	05	7,801			7,801	7,801	U
127	0604768A	Brilliant Anti-Armor Submunition (BAT)	05	25,000			25,000	25,000	U
128	0604780A	Combined Arms Tactical Trainer (CATT) Core	05	9,241			9,241	9,241	U
129	0604798A	Brigade Analysis, Integration and Evaluation	05	42,634			42,634	42,634	U
130	0604802A	Weapons and Munitions - Eng Dev	05	181,023			181,023	181,023	U

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131	0604804A	Logistics and Engineer Equipment - Eng Dev	05	76,030	76,388		76,388	U
132	0604805A	Command, Control, Communications Systems - Eng Dev	05	9,559	15,950		15,950	U
133	0604807A	Medical Materiel/Medical Biological Defense Equipment - Eng Dev	05	36,685	44,495		44,495	U
134	0604808A	Landmine Warfare/Barrier - Eng Dev	05	26,188	43,064		43,064	U
135	0604818A	Army Tactical Command & Control Hardware & Software	05	157,852	169,607		169,607	U
136	0604820A	Radar Development	05	31,651	39,289		39,289	U
137	0604822A	General Fund Enterprise Business System (GFEBs)	05	47,575	36,810		36,810	U
138	0604823A	Firefinder	05	43,762	27,439		27,439	U
139	0604827A	Soldier Systems - Warrior Dem/Val	05	15,490	10,382		10,382	U
140	0604852A	Suite of Survivability Enhancement Systems - EMD	05	90,187	52,839		52,839	U
141	0604854A	Artillery Systems - EMD	05	3,892	1,779		1,779	U
142	0605013A	Information Technology Development	05	62,613	77,686		77,686	U
143	0605018A	Integrated Personnel and Pay System-Army (IPPS-A)	05	188,637	164,899		164,899	U
144	0605028A	Armored Multi-Purpose Vehicle (AMPV)	05	184,300	111,821		111,821	U
145	0605029A	Integrated Ground Security Surveillance Response Capability (IGSSR-C)	05	4,241	3,207		3,207	U
146	0605030A	Joint Tactical Network Center (JTNC)	05	15,242	15,869		15,869	U

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131	0604804A	Logistics and Engineer Equipment - Eng Dev	05	103,226				103,226	U
132	0604805A	Command, Control, Communications Systems - Eng Dev	05	12,595				12,595	U
133	0604807A	Medical Materiel/Medical Biological Defense Equipment - Eng Dev	05	48,264				48,264	U
134	0604808A	Landmine Warfare/Barrier - Eng Dev	05	39,208				39,208	U
135	0604818A	Army Tactical Command & Control Hardware & Software	05	140,637				140,637	U
136	0604820A	Radar Development	05	105,243				105,243	U
137	0604822A	General Fund Enterprise Business System (GFEBs)	05	46,683				46,683	U
138	0604823A	Firefinder	05	17,294				17,294	U
139	0604827A	Soldier Systems - Warrior Dem/Val	05	5,803				5,803	U
140	0604852A	Suite of Survivability Enhancement Systems - EMD	05	98,698				98,698	U
141	0604854A	Artillery Systems - EMD	05	15,832				15,832	U
142	0605013A	Information Technology Development	05	126,537				126,537	U
143	0605018A	Integrated Personnel and Pay System-Army (IPPS-A)	05	142,773				142,773	U
144	0605028A	Armored Multi-Purpose Vehicle (AMPV)	05	96,730				96,730	U
145	0605029A	Integrated Ground Security Surveillance Response Capability (IGSSR-C)	05	6,699				6,699	U
146	0605030A	Joint Tactical Network Center (JTNC)	05	15,882				15,882	U

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147	0605031A	Joint Tactical Network (JTN)	05	46,051	41,920		41,920	U
148	0605032A	TRACTOR TIRE	05	118,570	41,166	66,760	107,926	U
149	0605033A	Ground-Based Operational Surveillance System - Expeditionary (GBOSS-E)	05	20,661	5,169		5,169	U
150	0605034A	Tactical Security System (TSS)	05	3,998	4,490		4,490	U
151	0605035A	Common Infrared Countermeasures (CIRCM)	05	97,746	31,139	2,670	33,809	U
152	0605036A	Combating Weapons of Mass Destruction (CWMD)	05	6,650	11,297		11,297	U
153	0605037A	Evidence Collection and Detainee Processing	05	206				U
154	0605038A	Nuclear Biological Chemical Reconnaissance Vehicle (NBCRV) Sensor Suite	05	15,481	15,135		15,135	U
155	0605041A	Defensive CYBER Tool Development	05	41,441	33,796		33,796	U
156	0605042A	Tactical Network Radio Systems (Low-Tier)	05	8,845	3,825		3,825	U
157	0605047A	Contract Writing System	05	19,574	41,876		41,876	U
158	0605049A	Missile Warning System Modernization (MWSM)	05	12,480	8,266		8,266	U
159	0605051A	Aircraft Survivability Development	05	169,752	21,938	34,933	56,871	U
160	0605052A	Indirect Fire Protection Capability Inc 2 - Block 1	05	156,361	132,283		132,283	U
161	0605053A	Ground Robotics	05	60,530	71,435		71,435	U

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147	0605031A	Joint Tactical Network (JTN)	05	40,808				40,808	U
148	0605032A	TRACTOR TIRE	05						U
149	0605033A	Ground-Based Operational Surveillance System - Expeditionary (GBOSS-E)	05	3,847				3,847	U
150	0605034A	Tactical Security System (TSS)	05	6,928				6,928	U
151	0605035A	Common Infrared Countermeasures (CIRCM)	05	34,488		11,770	11,770	46,258	U
152	0605036A	Combating Weapons of Mass Destruction (CWMD)	05	10,000				10,000	U
153	0605037A	Evidence Collection and Detainee Processing	05						U
154	0605038A	Nuclear Biological Chemical Reconnaissance Vehicle (NBCRV) Sensor Suite	05	6,054				6,054	U
155	0605041A	Defensive CYBER Tool Development	05	62,262				62,262	U
156	0605042A	Tactical Network Radio Systems (Low-Tier)	05	35,654				35,654	U
157	0605047A	Contract Writing System	05	19,682				19,682	U
158	0605049A	Missile Warning System Modernization (MWSM)	05	1,539				1,539	U
159	0605051A	Aircraft Survivability Development	05	64,557		77,420	77,420	141,977	U
160	0605052A	Indirect Fire Protection Capability Inc 2 - Block 1	05	243,228				243,228	U
161	0605053A	Ground Robotics	05	41,308				41,308	U

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162	0605054A	Emerging Technology Initiatives	05		42,813		42,813	U
163	0605203A	Army System Development & Demonstration	05					U
164	0605380A	AMF Joint Tactical Radio System (JTRS)	05	18,639	15,964		15,964	U
165	0605450A	Joint Air-to-Ground Missile (JAGM)	05	28,539	11,758		11,758	U
166	0605457A	Army Integrated Air and Missile Defense (AIAMD)	05	339,051	322,263		322,263	U
167	0605625A	Manned Ground Vehicle	05					U
168	0605766A	National Capabilities Integration (MIP)	05	9,382	12,340		12,340	U
169	0605812A	Joint Light Tactical Vehicle (JLTV) Engineering and Manufacturing Development Ph	05	22,530				U
170	0605830A	Aviation Ground Support Equipment	05	6,653	7,703		7,703	U
171	0210609A	Paladin Integrated Management (PIM)	05	5,868				U
172	0303032A	TROJAN - RH12	05	5,631	4,521	1,200	5,721	U
173	0303267A	Auctioned Spectrum Relocation Fund	05	15,885				U
174	0304270A	Electronic Warfare Development	05	14,616	8,922		8,922	U
175	1205117A	Tractor Bears	05	17,928	23,170		23,170	U
		System Development & Demonstration		3,349,488	2,965,361	236,863	3,202,224	
176	0604256A	Threat Simulator Development	06	31,401	47,322		47,322	U
177	0604258A	Target Systems Development	06	13,467	32,120		32,120	U

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162	0605054A	Emerging Technology Initiatives	05	45,896				45,896	U
163	0605203A	Army System Development & Demonstration	05	164,883		19,527	19,527	184,410	U
164	0605380A	AMF Joint Tactical Radio System (JTRS)	05						U
165	0605450A	Joint Air-to-Ground Missile (JAGM)	05	9,500				9,500	U
166	0605457A	Army Integrated Air and Missile Defense (AIAMD)	05	208,938				208,938	U
167	0605625A	Manned Ground Vehicle	05	378,400				378,400	U
168	0605766A	National Capabilities Integration (MIP)	05	7,835				7,835	U
169	0605812A	Joint Light Tactical Vehicle (JLTV) Engineering and Manufacturing Development Ph	05	2,732				2,732	U
170	0605830A	Aviation Ground Support Equipment	05	1,664				1,664	U
171	0210609A	Paladin Integrated Management (PIM)	05						U
172	0303032A	TROJAN - RH12	05	3,936				3,936	U
173	0303267A	Auctioned Spectrum Relocation Fund	05						U
174	0304270A	Electronic Warfare Development	05	19,675		3,200	3,200	22,875	U
175	1205117A	Tractor Bears	05						U
		System Development & Demonstration		3,549,431		111,917	111,917	3,661,348	
176	0604256A	Threat Simulator Development	06	14,117				14,117	U
177	0604258A	Target Systems Development	06	8,327				8,327	U

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

Line No	Program Element Number	Item	Act	FY 2018 (Base + OCO)	FY 2019 Base Enacted	FY 2019 OCO Enacted	FY 2019 Total Enacted	S e c
178	0604759A	Major T&E Investment	06	113,516	82,893		82,893	U
179	0605103A	Rand Arroyo Center	06	19,336	19,796		19,796	U
180	0605301A	Army Kwajalein Atoll	06	234,010	246,275		246,275	U
181	0605326A	Concepts Experimentation Program	06	28,701	30,394		30,394	U
182	0605502A	Small Business Innovative Research	06	284,080				U
183	0605601A	Army Test Ranges and Facilities	06	313,589	315,634		315,634	U
184	0605602A	Army Technical Test Instrumentation and Targets	06	57,395	84,805		84,805	U
185	0605604A	Survivability/Lethality Analysis	06	41,296	40,480		40,480	U
186	0605606A	Aircraft Certification	06	4,612	3,936		3,936	U
187	0605702A	Meteorological Support to RDT&E Activities	06	7,070	9,759		9,759	U
188	0605706A	Materiel Systems Analysis	06	21,694	21,223		21,223	U
189	0605709A	Exploitation of Foreign Items	06	12,684	13,026		13,026	U
190	0605712A	Support of Operational Testing	06	50,723	52,705		52,705	U
191	0605716A	Army Evaluation Center	06	56,003	57,039		57,039	U
192	0605718A	Army Modeling & Sim X-Cmd Collaboration & Integ	06	1,756	2,798		2,798	U
193	0605801A	Programwide Activities	06	54,383	60,921		60,921	U
194	0605803A	Technical Information Activities	06	39,613	29,024		29,024	U
195	0605805A	Munitions Standardization, Effectiveness and Safety	06	65,709	72,279		72,279	U

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Line No	Program Element Number	Item	Act	FY 2020 Base	FY 2020 OCO for Base Requirements	FY 2020 OCO for Direct War and Enduring Costs	FY 2020 Total OCO	FY 2020 Total (Base + OCO)	Se
178	0604759A	Major T&E Investment	06	136,565			136,565	U	
179	0605103A	Rand Arroyo Center	06	13,113			13,113	U	
180	0605301A	Army Kwajalein Atoll	06	238,691			238,691	U	
181	0605326A	Concepts Experimentation Program	06	42,922			42,922	U	
182	0605502A	Small Business Innovative Research	06					U	
183	0605601A	Army Test Ranges and Facilities	06	334,468			334,468	U	
184	0605602A	Army Technical Test Instrumentation and Targets	06	46,974			46,974	U	
185	0605604A	Survivability/Lethality Analysis	06	35,075			35,075	U	
186	0605606A	Aircraft Certification	06	3,461			3,461	U	
187	0605702A	Meteorological Support to RDT&E Activities	06	6,233			6,233	U	
188	0605706A	Materiel Systems Analysis	06	21,342			21,342	U	
189	0605709A	Exploitation of Foreign Items	06	11,168			11,168	U	
190	0605712A	Support of Operational Testing	06	52,723			52,723	U	
191	0605716A	Army Evaluation Center	06	60,815			60,815	U	
192	0605718A	Army Modeling & Sim X-Cmd Collaboration & Integ	06	2,527			2,527	U	
193	0605801A	Programwide Activities	06	58,175			58,175	U	
194	0605803A	Technical Information Activities	06	25,060			25,060	U	
195	0605805A	Munitions Standardization, Effectiveness and Safety	06	44,458			44,458	U	

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Line No	Program Element Number	Item	Act	FY 2018 (Base + OCO)	FY 2019 Base Enacted	FY 2019 OCO Enacted	FY 2019 Total Enacted	S e c
196	0605857A	Environmental Quality Technology Mgmt Support	06	4,883	3,211		3,211	U
197	0605898A	Army Direct Report Headquarters - R&D - MHA	06	54,177	54,130		54,130	U
198	0606001A	Military Ground-Based CREW Technology	06	7,600	4,890		4,890	U
199	0606002A	Ronald Reagan Ballistic Missile Defense Test Site	06	59,042	62,940		62,940	U
200	0606003A	CounterIntel and Human Intel Modernization	06		2,636		2,636	U
201	0606942A	Assessments and Evaluations Cyber Vulnerabilities	06		88,300		88,300	U
202	0303260A	Defense Military Deception Initiative	06	1,708				U
203	0909999A	Financing for Cancelled Account Adjustments	06	654				U
		RDT&E Management Support		1,579,102	1,438,536		1,438,536	
204	0603778A	MLRS Product Improvement Program	07	10,286	6,877		6,877	U
205	0603813A	TRACTOR PULL	07	4,014	4,067		4,067	U
206	0605024A	Anti-Tamper Technology Support	07	4,009	7,251		7,251	U
207	0607131A	Weapons and Munitions Product Improvement Programs	07	16,302	16,003	2,548	18,551	U
208	0607133A	TRACTOR SMOKE	07	12,143	4,577	7,780	12,357	U
209	0607134A	Long Range Precision Fires (LRPF)	07	80,690	159,278		159,278	U
210	0607135A	Apache Product Improvement Program	07	55,565	24,019		24,019	U

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Line No	Program Element Number	Item	Act	FY 2020 Base	FY 2020 OCO for Base Requirements	FY 2020 OCO for Direct War and Enduring Costs	FY 2020 Total OCO	FY 2020 Total (Base + OCO)	\$ e c
196	0605857A	Environmental Quality Technology Mgmt Support	06	4,681				4,681	U
197	0605898A	Army Direct Report Headquarters - R&D - MHA	06	53,820				53,820	U
198	0606001A	Military Ground-Based CREW Technology	06	4,291				4,291	U
199	0606002A	Ronald Reagan Ballistic Missile Defense Test Site	06	62,069				62,069	U
200	0606003A	CounterIntel and Human Intel Modernization	06	1,050		1,875	1,875	2,925	U
201	0606942A	Assessments and Evaluations Cyber Vulnerabilities	06	4,500				4,500	U
202	0303260A	Defense Military Deception Initiative	06						U
203	0909999A	Financing for Cancelled Account Adjustments	06						U
	RDT&E	Management Support		1,286,625		1,875	1,875	1,288,500	
204	0603778A	MLRS Product Improvement Program	07	22,877				22,877	U
205	0603813A	TRACTOR PULL	07						U
206	0605024A	Anti-Tamper Technology Support	07	8,491				8,491	U
207	0607131A	Weapons and Munitions Product Improvement Programs	07	15,645				15,645	U
208	0607133A	TRACTOR SMOKE	07						U
209	0607134A	Long Range Precision Fires (LRPF)	07	164,182				164,182	U
210	0607135A	Apache Product Improvement Program	07						U

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Line No	Program Element Number	Item	Act	FY 2018 (Base + OCO)	FY 2019 Base Enacted	FY 2019 OCO Enacted	FY 2019 Total Enacted	S e c
211	0607136A	Blackhawk Product Improvement Program	07	48,241	35,196		35,196	U
212	0607137A	Chinook Product Improvement Program	07	155,433	144,722		144,722	U
213	0607138A	Fixed Wing Product Improvement Program	07	7,782	2,280		2,280	U
214	0607139A	Improved Turbine Engine Program	07	167,532	188,903		188,903	U
215	0607140A	Emerging Technologies from NIE	07	26,112				U
216	0607142A	Aviation Rocket System Product Improvement and Development	07	9,662	38,452		38,452	U
217	0607143A	Unmanned Aircraft System Universal Products	07	36,926	38,331		38,331	U
218	0607145A	Apache Future Development	07					U
219	0607312A	Army Operational Systems Development	07					U
220	0607665A	Family of Biometrics	07	3,032	2,397		2,397	U
221	0607865A	Patriot Product Improvement	07	77,391	75,288		75,288	U
222	0203728A	Joint Automated Deep Operation Coordination System (JADOCS)	07	32,256	30,915		30,915	U
223	0203735A	Combat Vehicle Improvement Programs	07	293,921	336,063		336,063	U
224	0203740A	Maneuver Control System	07	6,443				U
225	0203743A	155mm Self-Propelled Howitzer Improvements	07	39,154	37,155		37,155	U
226	0203744A	Aircraft Modifications/Product Improvement Programs	07	34,228	17,684		17,684	U

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Line No	Program Element Number	Item	Act	FY 2020 Base	FY 2020 OCO for Base Requirements	FY 2020 OCO for Direct War and Enduring Costs	FY 2020 Total OCO	FY 2020 Total (Base + OCO)	Se
211	0607136A	Blackhawk Product Improvement Program	07	13,039				13,039	U
212	0607137A	Chinook Product Improvement Program	07	174,371				174,371	U
213	0607138A	Fixed Wing Product Improvement Program	07	4,545				4,545	U
214	0607139A	Improved Turbine Engine Program	07	206,434				206,434	U
215	0607140A	Emerging Technologies from NIE	07						U
216	0607142A	Aviation Rocket System Product Improvement and Development	07	24,221				24,221	U
217	0607143A	Unmanned Aircraft System Universal Products	07	32,016				32,016	U
218	0607145A	Apache Future Development	07	5,448				5,448	U
219	0607312A	Army Operational Systems Development	07	49,526				49,526	U
220	0607665A	Family of Biometrics	07	1,702				1,702	U
221	0607865A	Patriot Product Improvement	07	96,430				96,430	U
222	0203728A	Joint Automated Deep Operation Coordination System (JADOCs)	07	47,398				47,398	U
223	0203735A	Combat Vehicle Improvement Programs	07	334,463				334,463	U
224	0203740A	Maneuver Control System	07						U
225	0203743A	155mm Self-Propelled Howitzer Improvements	07	214,246				214,246	U
226	0203744A	Aircraft Modifications/Product Improvement Programs	07	16,486				16,486	U

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Line No	Program Element Number	Item	Act	FY 2018 (Base + OCO)	FY 2019 Base Enacted	FY 2019 OCO Enacted	FY 2019 Total Enacted	S e c
227	0203752A	Aircraft Engine Component Improvement Program	07	139	146		146	U
228	0203758A	Digitization	07	4,611	6,308		6,308	U
229	0203801A	Missile/Air Defense Product Improvement Program	07	43,615	1,641	2,000	3,641	U
230	0203802A	Other Missile Product Improvement Programs	07	4,800	4,941		4,941	U
231	0203808A	TRACTOR CARD	07	37,883	34,050		34,050	U
232	0205402A	Integrated Base Defense - Operational System Dev	07			8,000	8,000	U
233	0205410A	Materials Handling Equipment	07	1,519	1,462		1,462	U
234	0205412A	Environmental Quality Technology - Operational System Dev	07	187	249		249	U
235	0205456A	Lower Tier Air and Missile Defense (AMD) System	07	69,558	77,188		77,188	U
236	0205778A	Guided Multiple-Launch Rocket System (GMLRS)	07	93,900	118,955		118,955	U
238	0303028A	Security and Intelligence Activities	07	35,652	12,277	23,199	35,476	U
239	0303140A	Information Systems Security Program	07	108,755	42,520		42,520	U
240	0303141A	Global Combat Support System	07	45,372	53,855		53,855	U
241	0303150A	WWMCCS/Global Command and Control System	07	10,055	2,031		2,031	U
244	0305172A	Combined Advanced Applications	07	1,100	1,500		1,500	U
245	0305179A	Integrated Broadcast Service (IBS)	07		450		450	U

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Line No	Program Element Number	Item	Act	FY 2020 Base	FY 2020 OCO for Base Requirements	FY 2020 OCO for Direct War and Enduring Costs	FY 2020 Total OCO	FY 2020 Total (Base + OCO)	Se
227	0203752A	Aircraft Engine Component Improvement Program	07	144				144	U
228	0203758A	Digitization	07	5,270				5,270	U
229	0203801A	Missile/Air Defense Product Improvement Program	07	1,287				1,287	U
230	0203802A	Other Missile Product Improvement Programs	07						U
231	0203808A	TRACTOR CARD	07						U
232	0205402A	Integrated Base Defense - Operational System Dev	07						U
233	0205410A	Materials Handling Equipment	07						U
234	0205412A	Environmental Quality Technology - Operational System Dev	07	732				732	U
235	0205456A	Lower Tier Air and Missile Defense (AMD) System	07	107,746				107,746	U
236	0205778A	Guided Multiple-Launch Rocket System (GMLRS)	07	138,594				138,594	U
238	0303028A	Security and Intelligence Activities	07	13,845		22,904	22,904	36,749	U
239	0303140A	Information Systems Security Program	07	29,185				29,185	U
240	0303141A	Global Combat Support System	07	68,976				68,976	U
241	0303150A	WWMCCS/Global Command and Control System	07	2,073				2,073	U
244	0305172A	Combined Advanced Applications	07						U
245	0305179A	Integrated Broadcast Service (IBS)	07	459				459	U

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Line No	Program Element Number	Item	Act	FY 2018 (Base + OCO)	FY 2019 Base Enacted	FY 2019 OCO Enacted	FY 2019 Total Enacted	Se
246	0305204A	Tactical Unmanned Aerial Vehicles	07	16,925	6,000		6,000	U
247	0305206A	Airborne Reconnaissance Systems	07	20,080	12,416	14,000	26,416	U
248	0305208A	Distributed Common Ground/Surface Systems	07	24,700	27,109		27,109	U
249	0305219A	MQ-1C Gray Eagle UAS	07	10,531				U
250	0305232A	RQ-11 UAV	07	12,691	6,180		6,180	U
251	0305233A	RQ-7 UAV	07	12,773	17,863		17,863	U
252	0307665A	Biometrics Enabled Intelligence	07	8,573	4,310	2,214	6,524	U
253	0708045A	End Item Industrial Preparedness Activities	07	118,410	108,696		108,696	U
254	1203142A	SATCOM Ground Environment (SPACE)	07	9,945	12,105		12,105	U
255	1208053A	Joint Tactical Ground System	07	10,228	7,400		7,400	U
9999	9999999999	Classified Programs		7,154	5,955		5,955	U
		Operational Systems Development		1,830,278	1,735,065	59,741	1,794,806	
Total Research, Development, Test & Eval, Army				11,633,461	11,074,556	300,604	11,375,160	

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246	0305204A	Tactical Unmanned Aerial Vehicles	07	5,097		34,100	34,100	39,197	U
247	0305206A	Airborne Reconnaissance Systems	07	11,177		14,000	14,000	25,177	U
248	0305208A	Distributed Common Ground/Surface Systems	07	38,121				38,121	U
249	0305219A	MQ-1C Gray Eagle UAS	07						U
250	0305232A	RQ-11 UAV	07	3,218				3,218	U
251	0305233A	RQ-7 UAV	07	7,817				7,817	U
252	0307665A	Biometrics Enabled Intelligence	07	2,000		2,214	2,214	4,214	U
253	0708045A	End Item Industrial Preparedness Activities	07	59,848				59,848	U
254	1203142A	SATCOM Ground Environment (SPACE)	07	34,169				34,169	U
255	1208053A	Joint Tactical Ground System	07	10,275				10,275	U
9999	9999999999	Classified Programs		7,273				7,273	U
		Operational Systems Development		1,978,826		73,218	73,218	2,052,044	
Total Research, Development, Test & Eval, Army				12,192,771		204,124	204,124	12,396,895	

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18	02	0602150A	Air and Missile Defense Technology.....	321
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27	02	0602622A	Chemical, Smoke and Equipment Defeating Technology.....	434
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29	02	0602624A	Weapons and Munitions Technology.....	444
30	02	0602705A	Electronics and Electronic Devices.....	460
31	02	0602709A	Night Vision Technology.....	483
32	02	0602712A	Countermeasure Systems.....	491
33	02	0602716A	Human Factors Engineering Technology.....	499
34	02	0602720A	Environmental Quality Technology.....	509
35	02	0602782A	Command, Control, Communications Technology.....	523
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37	02	0602784A	Military Engineering Technology.....	544
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Ballistics Technology	0602618A	26	02.....	424
C3I Applied Cyber	0602213A	20	02.....	353
Chemical, Smoke and Equipment Defeating Technology	0602622A	27	02.....	434
Combat Vehicle and Automotive Technology	0602601A	25	02.....	408
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Missile Technology	0602303A	22	02.....	379
Network C3I Technology	0602146A	15	02.....	178
Next Generation Combat Vehicle Technology	0602145A	14	02.....	116
Night Vision Technology	0602709A	31	02.....	483
Sensors and Electronic Survivability	0602120A	7	02.....	13
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Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602105A / <i>Materials Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	73.136	83.586	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	156.722
H7B: <i>Advanced Materials Initiatives (CA)</i>	-	44.000	55.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	99.000
H7G: <i>Nanomaterials Applied Research</i>	-	2.982	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	2.982
H84: <i>Materials</i>	-	26.154	24.092	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	50.246
XW4: <i>Manufacturing Science</i>	-	0.000	4.494	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.494

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.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602105A / <i>Materials Technology</i>
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B. Program Change Summary (\$ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	29.640	28.600	28.823	-	28.823
Current President's Budget	73.136	83.586	0.000	-	0.000
Total Adjustments	43.496	54.986	-28.823	-	-28.823
• Congressional General Reductions	-0.011	-0.014			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	44.000	55.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.493	-			
• Adjustments to Budget Years	-	-	-28.823	-	-28.823

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: H7B: *Advanced Materials Initiatives (CA)*

Congressional Add: *Program Increase*

Congressional Add: *High end materials for military applications*

Congressional Add: *Materials technology for high performance polymers research*

Congressional Add Subtotals for Project: H7B

Congressional Add Totals for all Projects

	FY 2018	FY 2019
	24.000	55.000
	5.000	-
	15.000	-
Congressional Add Subtotals for Project: H7B	44.000	55.000
Congressional Add Totals for all Projects	44.000	55.000

Change Summary Explanation

FY18 increase related to \$44.000 million of Congressional Add funding.
 FY19 increase related to \$55.000 million of Congressional Add funding.
 FY20 decrease related to science and technology financial restructuring.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602105A / <i>Materials Technology</i>				Project (Number/Name) H7B / <i>Advanced Materials Initiatives (CA)</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H7B: <i>Advanced Materials Initiatives (CA)</i>	-	44.000	55.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	99.000

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 2018	FY 2019
Congressional Add: Program Increase	24.000	55.000
FY 2018 Accomplishments: Program Increase		
FY 2019 Plans: Program Increase		
Congressional Add: High end materials for military applications	5.000	-
FY 2018 Accomplishments: High end materials for military applications		
Congressional Add: Materials technology for high performance polymers research	15.000	-
FY 2018 Accomplishments: Materials technology for high performance polymers research		
Congressional Adds Subtotals	44.000	55.000

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602105A / <i>Materials Technology</i>				Project (Number/Name) H7G / <i>Nanomaterials Applied Research</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H7G: <i>Nanomaterials Applied Research</i>	-	2.982	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	2.982

Note

Project H7G (Nanomaterials Applied Research) concluded in FY 2018.

A. Mission Description and Budget Item Justification

This Project conducts nanoscience research relevant to the soldier focused on new materials, properties and phenomena in five research areas: (1) lightweight, multifunctional nanostructured materials and hybrid assemblies, (2) soldier medicine, (3) multiple blast and ballistic threats, (4) hazardous substances sensing, recognition, and protection, and (5) nanosystem integration for protected communications, diagnostic sensing, and operational flexibility in complex environments. This Project funds collaborative applied research and integration of government, academic, and industry scientific research on nanomaterials derived from PE 0601104A (University and Industry Research Centers) / Project J12 (Institute for Soldier Nanotechnologies (ISN)) to advance innovative capabilities.

This Project sustains Army Science and Technology efforts supporting the Soldier portfolio.

Work in this Project builds on the materials research transitioned from PE 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.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Emerging Materials for Soldier Protection	2.982	-	-
Description: Identify, exploit, scale-up, and accelerate the transition of promising breakthroughs in materials research, including nanomaterials, biotechnology, multifunctional materials, and processing science research, via collaborative government, academia, and industry to deliver new materials technologies that revolutionize soldier capabilities and enable expeditionary operations.			
Accomplishments/Planned Programs Subtotals	2.982	-	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army Date: March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602105A / <i>Materials Technology</i>	Project (Number/Name) H7G / <i>Nanomaterials Applied Research</i>
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D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602105A / <i>Materials Technology</i>			Project (Number/Name) H84 / <i>Materials</i>				
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H84: <i>Materials</i>	-	26.154	24.092	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	50.246

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 2018	FY 2019	FY 2020
Title: Structural Armor Materials	3.920	3.899	-
Description: Conduct applied research to design 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. Explore ground			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602105A / <i>Materials Technology</i>	Project (Number/Name) H84 / <i>Materials</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>vehicle structural mechanics and dynamics technologies to improve damage tolerance, durability, fatigue-resistance, and dynamic response (shock, vibration, harshness, and damping).</p> <p>FY 2019 Plans: Will investigate new magnesium alloy compositions that offer improved, lightweight ballistic resistance using first principles methods and techniques; will assess the causes of delayed cracking in high hardness armor steel by performing stress corrosion cracking characterization on a statistically significant number of armor plates.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: FY2020 funds realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BI4 (Materials Application and Integration Technology) as part of financial restructure.</p>				
<p>Title: Soldier-Borne Armor Materials</p> <p>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.</p> <p>FY 2019 Plans: Will demonstrate efficient and complete synthesis of boron suboxide (B6O) armor ceramics, quantify effects of powder morphology, size and size distribution, and characterize the critical mechanical properties versus reactive hot pressing process conditions; develop processing pathways to fabricate armor ceramic with novel multiscale heterogeneity and characterize ballistic performance.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: FY 2020 funds realigned to PE 0602143A (Soldier Lethality Technology) / Project AZ5 (Soldier Protection Technology ? Vulnerability) as part of financial restructure.</p>		6.966	4.873	-
<p>Title: Lethality Materials Technology</p> <p>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.</p> <p>FY 2019 Plans:</p>		3.662	3.764	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602105A / <i>Materials Technology</i>	Project (Number/Name) H84 / <i>Materials</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Will finalize alloy selection and process development of novel, non-cobalt containing, binders for tungsten carbide based armor piercing projectiles; will utilize atmospheric plasma chemical vapor deposition to synthesize films of metastable material phases for use in energetics applications.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: FY 2020 funds realigned to PE 0602141A (Lethality Technology) / Project AH8 (Lethality Materials and Processes Technology) as part of financial restructure.</p>				
<p>Title: Multifunctional Armor Materials</p> <p>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).</p> <p>FY 2019 Plans: Apply multi-objective topological optimization algorithms to develop multi-functional design in critical components to address lightweight goals; will develop stimuli-responsive methods to change material stiffness using low power mechanisms that also provide faster response times; will develop three-dimensional phase diagrams that incorporate magnetic field influence over phase formation by visualizing temperature-composition-field relationships; and will develop meta material structures that can be reconfigured rapidly and with spatial complexity to re-direct load paths or enhance energy absorption in real time.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: The Multifunctional Armor Materials effort is being realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BI4 (Materials and Manufacturing Research Technology), and PE 0602143A (Soldier Lethality Technology / Project AZ5 (Soldier Protection Technology - Vulnerability) as part of financial restructure.</p>		9.621	6.089	-
<p>Title: Nanomaterials</p> <p>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).</p> <p>FY 2019 Plans:</p>		1.985	2.018	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602105A / <i>Materials Technology</i>	Project (Number/Name) H84 / <i>Materials</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>Develop scalable mechanical alloying methods for nanocrystalline copper-tantalum with parametric variation of phase chemistry, sintering time, temperature, texture evolution, grain size refinement, and secondary phase formation/distribution; will investigate the processing of aluminum alloys with novel chemistries for the generation of hydrogen through nano-galvanic cell formation.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: FY 2020 funds realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BI4 (Materials Application and Integration Technology) as part of financial restructure.</p>			
<p>Title: Bio-enabled Materials and Processes</p> <p>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.</p> <p>FY 2019 Plans: Will conduct rapid design, selection and production of peptide reagents for potential applications such as the improvement of sensor devices, and logistics and sustainment; and will design and develop specialty materials via synthetic biology for potential applications that will improve safety, cost, logistics, robustness, and create new abilities to adapt existing materiel.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: FY 2020 funds realigned to PE 0602143A (Soldier Lethality Technology) / Project BE6 (Reactive/Responsive Surfaces and Materials ? Soldier and Systems) as part of financial restructure.</p>	-	3.133	-
<p>Title: FY 2019 SBIR / STTR Transfer</p> <p>Description: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 Plans: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer</p>	-	0.316	-
Accomplishments/Planned Programs Subtotals	26.154	24.092	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602105A / <i>Materials Technology</i>	Project (Number/Name) H84 / <i>Materials</i>

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602105A / <i>Materials Technology</i>				Project (Number/Name) XW4 / <i>Manufacturing Science</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>XW4: Manufacturing Science</i>	-	0.000	4.494	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.494

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 2018	FY 2019	FY 2020
Title: Agile Expedient Manufacturing	-	4.330	-
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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602105A / <i>Materials Technology</i>	Project (Number/Name) XW4 / <i>Manufacturing Science</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
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. <i>FY 2019 Plans:</i> Will quantify processing-structure-property relationships in additively manufactured steel alloys; validate continuum scale finite element-based model of laser-metal powder bed additive manufacturing process and mesoscale phase field model of microstructure prediction. <i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> FY 2020 funds realigned to PE 0602144A (Ground Technology) / Project BL1 (Materials and Manufacturing Research Technology) as part of financial restructure.			
<i>Title:</i> FY 2019 SBIR / STTR Transfer <i>Description:</i> FY 2019 SBIR / STTR Transfer <i>FY 2019 Plans:</i> FY 2019 SBIR / STTR Transfer <i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> FY 2019 SBIR / STTR Transfer	-	0.164	-
Accomplishments/Planned Programs Subtotals	-	4.494	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602120A / <i>Sensors and Electronic Survivability</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	83.581	80.849	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	164.430
H16: <i>S3I Technology</i>	-	19.872	19.419	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	39.291
SA1: <i>Sensors and Electronic Initiatives (CA)</i>	-	45.500	48.500	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	94.000
SA2: <i>Biotechnology Applied Research</i>	-	1.635	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.635
TS1: <i>Tactical Space Research</i>	-	6.797	3.495	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	10.292
TS2: <i>Robotics Technology</i>	-	9.777	9.435	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	19.212

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 Program Element (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),

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602120A / <i>Sensors and Electronic Survivability</i>
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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 Army Futures Command.

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

B. Program Change Summary (\$ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	35.730	32.366	31.106	-	31.106
Current President's Budget	83.581	80.849	0.000	-	0.000
Total Adjustments	47.851	48.483	-31.106	-	-31.106
• Congressional General Reductions	-0.013	-0.017			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	45.500	48.500			
• Congressional Directed Transfers	-	-			
• Reprogrammings	3.000	-			
• SBIR/STTR Transfer	-0.636	-			
• Adjustments to Budget Years	-	-	-31.106	-	-31.106

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: SA1: *Sensors and Electronic Initiatives (CA)*

Congressional Add: *Advanced Space Data Exp & Integ*

Congressional Add: *Agile Manufacturing Materials Processing*

Congressional Add: *Tactical Space-Small Sat Tech Dev*

Congressional Add: *Open Campus Initiative*

Congressional Add Subtotals for Project: SA1

Congressional Add Totals for all Projects

	FY 2018	FY 2019
	7.500	9.500
	23.000	15.000
	15.000	20.000
	-	4.000
Congressional Add Subtotals for Project: SA1	45.500	48.500
Congressional Add Totals for all Projects	45.500	48.500

Change Summary Explanation

FY18 increase related to \$45.500 million of Congressional Add funding
 FY19 increase related to \$48.500 million of Congressional Add funding.
 FY20 decrease related to Science and Technology financial restructuring.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602120A / <i>Sensors and Electronic Survivability</i>				Project (Number/Name) H16 / <i>S3I Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H16: <i>S3I Technology</i>	-	19.872	19.419	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	39.291

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 and Communications, 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 Project

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / <i>Sensors and Electronic Survivability</i>	Project (Number/Name) H16 / <i>S3I Technology</i>
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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.

FY 2020 realignments are due to financial restructuring in support of Army Modernization Priorities.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
<p>Title: Non-Imaging Intelligence, Surveillance, and Reconnaissance (ISR) Sensing</p> <p>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.</p> <p>FY 2019 Plans: Develop robust, low-cost acoustic sensors with 1 to 10000 Hz frequency response to detect and locate Army-relevant target signals in environments of interest; focus on sensor miniaturization and small arrays; will develop novel wind noise reduction techniques that are necessary for successful particle-velocity sensor operation in complex military scenarios and on mobile platforms; develop new tools to calibrate and characterize quasi-static E/H field sensors for long-wavelength applications, such as power-line sensing, anomaly detection, and low-frequency positioning/navigation/timing; develop novel detection, classification, and identification algorithms for new classes of targets; characterize and assess technologies and sensing modalities that can detect and identify improvised explosive threats, detect their components, and mitigate their delivery platforms; and develop and integrate automated multi-modal detection, tracking, classification and decision support tools for deployment on low resource tactical platforms, ground stations and sensors.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: FY 2020 funds realigned to PE 0602146A (Network C3I Technology) / Project AR1 (Robust, Resilient, Intelligent C3I Technology) as part of financial restructure in support of Army Modernization Priorities.</p>	6.996	6.169	-
<p>Title: Networked Sensing and Data Fusion</p> <p>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.</p>	5.137	4.547	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / <i>Sensors and Electronic Survivability</i>	Project (Number/Name) H16 / <i>S3I Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p><i>FY 2019 Plans:</i> Develop focused infrasonic classification methods and integrate them with long-range sound propagation models to increase classification accuracy; develop algorithms to provide automated tipping and cueing at each sensor array for incorporation into the analyst's common operating picture; develop tools for creating and visualizing a multi-sensor 3-dimensional (3D) common operating picture for real-time data geo-registration and fusion of heterogeneous data from multiple aerial and ground-based passive and active imaging sensors for increased situational awareness; develop tools for multimodal biometrics and human activity recognition using unconstrained video; explore scene representation models for optimized, real time implementation; develop theory for inference and subjective networks that benchmark performance against other uncertain reasoning methods; develop higher level fusion of event tracking from sensor and social media data in uncertain environments via subjective logic Bayesian networks; and develop robust capability for communications, sensors and data management and information fusion for a large network of ground sensors.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> FY 2020 funds realigned to PE 0602146A (Network C3I Technology) / Project AR1 (Robust, Resilient, Intelligent C3I Technology) as part of financial restructure in support of Army Modernization Priorities.</p>			
<p><i>Title:</i> RF Sensing for Concealed/Low-Signature Threat Detection (previously Ultra Wideband (UWB) Radar)</p> <p><i>Description:</i> 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.</p> <p><i>FY 2019 Plans:</i> Reduce sensor size with on-board signal processing for automated detection and tracking; investigate the benefits of cooperative RF sensing in complex environments; and will assess the processing constraints introduced by distributed sensing.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i></p>	2.713	2.967	-

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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / <i>Sensors and Electronic Survivability</i>	Project (Number/Name) H16 / <i>S3I Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
FY 2020 funds realigned to PE 0602146A (Network C3I Technology) / Project AP5 (Electronic Warfare Technology) and PE 0602148A (Future Vertical Lift Technology) / Project AL8 (Holistic Situational Awareness and Dec Making Tech) as part of financial restructure in support of Army Modernization Priorities.				
<p>Title: Laser Protection Technologies (previously Networked Compact Radar, Wide Bandgap Optoelectronics, and Laser Protection Technologies)</p> <p>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 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.</p> <p>FY 2019 Plans: Improve multi-chromophore solid-state optical limiter based on previous experimental results; investigate femtosecond limiter concepts in the mid-wave infrared; and conduct experiments to validate high power continuous wave laser protection concepts. These combined efforts will enable transmission of low light intensities, while blocking laser radiation with excessively high irradiance hence preventing sensor damage.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: FY20 funds realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BI2 (Sensor Protection Technology) as part of financial restructure in support of Army Modernization Priorities.</p>		4.957	5.054	-
<p>Title: Multi-Mode Air Defense Radar</p> <p>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.</p> <p>FY 2019 Plans:</p>		0.069	0.500	-

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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / <i>Sensors and Electronic Survivability</i>	Project (Number/Name) H16 / <i>S3I Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
Adapt front end RF technologies for next generation fires radars.				
FY 2019 to FY 2020 Increase/Decrease Statement: FY 2020 funds realigned to PE 0602150A (Air and Missile Defense Technology) / Project AD5 (Next Generation Fires Radar Technology) as part of financial restructure in support of Army Modernization Priorities.				
Title: FY 2019 SBIR / STTR Transfer		-	0.182	-
Description: FY 2019 SBIR / STTR Transfer				
FY 2019 Plans: FY 2019 SBIR / STTR Transfer				
FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer				
Accomplishments/Planned Programs Subtotals		19.872	19.419	-
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				
E. Performance Metrics				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602120A / <i>Sensors and Electronic Survivability</i>				Project (Number/Name) SA1 / <i>Sensors and Electronic Initiatives (CA)</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
SA1: <i>Sensors and Electronic Initiatives (CA)</i>	-	45.500	48.500	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	94.000

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 2018	FY 2019
Congressional Add: Advanced Space Data Exp & Integ	7.500	9.500
FY 2018 Accomplishments: Advanced Space Data Exp & Integ		
FY 2019 Plans: Advanced Space Data Exp & Integ		
Congressional Add: Agile Manufacturing Materials Processing	23.000	15.000
FY 2018 Accomplishments: Agile Manufacturing Materials Processing		
FY 2019 Plans: Agile Manufacturing Materials Processing		
Congressional Add: Tactical Space-Small Sat Tech Dev	15.000	20.000
FY 2018 Accomplishments: Tactical Space-Small Sat Tech Dev		
FY 2019 Plans: Tactical Space-Small Sat Tech Dev		
Congressional Add: Open Campus Initiative	-	4.000
FY 2019 Plans: Open Campus Initiative		
Congressional Adds Subtotals	45.500	48.500

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / <i>Sensors and Electronic Survivability</i>	Project (Number/Name) SA1 / <i>Sensors and Electronic Initiatives (CA)</i>
D. Acquisition Strategy N/A		
E. Performance Metrics N/A		

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / <i>Sensors and Electronic Survivability</i>	Project (Number/Name) SA2 / <i>Biotechnology Applied Research</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>SA2: Biotechnology Applied Research</i>	-	1.635	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	1.635

Note

This Project was completed in Fiscal Year (FY) 2018.

A. Mission Description and Budget Item Justification

This Project designs, develops and evaluates biotechnology with application to sensors, electronics, photonics, and network science. This Project funds collaborative applied research and integration of government, academic, and industry scientific research on biotechnology from Program Element (PE) 0601104A (University and Industry Research Centers) / Project H05 (Institute for Collaborative Biotechnologies) to advance innovative capabilities. Areas of applied research include bio-array sensors, biological, and bio-inspired power generation and storage, biomimetics, proteomics, genomics, network science, deoxyribonucleic acid (DNA) research and development, and control of protein and gene expression.

The Institute for Collaborative Biotechnologies (ICB) University Affiliated Research Center (UARC) is a collaborative effort led by the University of California, Santa Barbara (Santa Barbara, CA) in partnership with the California Institute of Technology (Pasadena, CA), the Massachusetts Institute of Technology (Cambridge, MA), the Army Laboratories and Research, Development and Engineering Centers, and the ICB industrial partners.

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

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Biotechnology Applied Research	1.635	-	-
Description: This effort exploits breakthroughs in biotechnology basic research accomplished at the ICB UARC to enable new capabilities in sensors, electronics, photonics, and network science.			
Accomplishments/Planned Programs Subtotals	1.635	-	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / <i>Sensors and Electronic Survivability</i>	Project (Number/Name) SA2 / <i>Biotechnology Applied Research</i>

E. Performance Metrics N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602120A / <i>Sensors and Electronic Survivability</i>				Project (Number/Name) TS1 / <i>Tactical Space Research</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
TS1: <i>Tactical Space Research</i>	-	6.797	3.495	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	10.292

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/Army Forces Strategic Command in Huntsville, AL.

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

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Tactical Space Research	FY 2018	FY 2019	FY 2020
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.	5.681	2.289	-
FY 2019 Plans: Refine tag, track and locate capabilities for ground objects of interest, advance space-based data exploitation technologies and components, space-based signal detection/processing/dissemination technologies, and software algorithms to enable cohesive exploitation from single or multiple small satellite platforms. Design and refine small satellite/payload components focused on			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / <i>Sensors and Electronic Survivability</i>	Project (Number/Name) TS1 / <i>Tactical Space Research</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
the improvement of warfighter tag, track, and location capabilities to include planning for tasking, processing, exploitation, and dissemination.				
FY 2019 to FY 2020 Increase/Decrease Statement: FY20 funds realigned to PE 0602146A (Network C3I Technology) / Project AO5 (Tag, Track and Locate Small Satellites Technology) as part of financial restructure in support of Army Modernization Priorities.				
Title: Space and Analysis Lab		1.116	1.127	-
Description: This effort provides an in-house capability to design and conduct analytic evaluations of space and high altitude technologies.				
FY 2019 Plans: Develop in-house research capabilities for small satellite/payload and component design, development and validation for tactical spacecraft; and assess new technologies for spacecraft components.				
FY 2019 to FY 2020 Increase/Decrease Statement: FY20 funds realigned to PE 0602146A (Network C3I Technology) / Project AO5 (Tag, Track and Locate Small Satellites Technology) as part of financial restructure in support of Army Modernization Priorities.				
Title: FY 2019 SBIR / STTR Transfer		-	0.079	-
Description: FY 2019 SBIR / STTR Transfer				
FY 2019 Plans: FY 2019 SBIR / STTR Transfer				
FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer				
Accomplishments/Planned Programs Subtotals		6.797	3.495	-
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / <i>Sensors and Electronic Survivability</i>	Project (Number/Name) TS1 / <i>Tactical Space Research</i>

<u>E. Performance Metrics</u> N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602120A / <i>Sensors and Electronic Survivability</i>				Project (Number/Name) TS2 / <i>Robotics Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
TS2: <i>Robotics Technology</i>	-	9.777	9.435	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	19.212

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.

FY 2020 realignments are due to financial restructuring in support of Army Modernization Priorities.

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Robotics CTA	FY 2018	FY 2019	FY 2020
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	3.675	3.208	-

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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / <i>Sensors and Electronic Survivability</i>	Project (Number/Name) TS2 / <i>Robotics Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
populated environments and minimize the cognitive workload on Soldier operators enabling more dexterous manipulation of objects.				
<p>FY 2019 Plans: Demonstrate cognitive architecture with the integrated capabilities of perception, intelligent control and tactical behavior, human-robot interaction, robotic manipulation, and unique mobility. A limbed robot employing dynamic locomotion solely through electromotive rotary actuators will be assessed with the Robotics CTA cognitive architecture for autonomous capability. Perception and intelligence for a dynamic limbed platform will be demonstrated to show its capacity for teaming in an optempo scenario. Whole body manipulation will be employed in conjunction with the cognitive architecture to demonstrate the ability to perform environment interactions autonomously in ad hoc scenarios.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: FY 2020 funds realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BF8 (Artificial Intelligence & Machine Learning Tech) as part of financial restructure in support of Army Modernization Priorities.</p>				
<p>Title: Perception and Intelligent Control</p> <p>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.</p> <p>FY 2019 Plans: Integrate a map-based and an ontology focused World Model to provide a more complete architecture for reasoning and understanding the environment. Cognitive approaches to perception will be implemented on robotic platforms and methods for artificial intelligence assessment will be employed to ensure future unmanned systems can offer transparency in their cognitive processes.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: FY 2020 funds realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BF8 (Artificial Intelligence & Machine Learning Tech) as part of financial restructure in support of Army Modernization Priorities.</p>		4.640	4.509	-
<p>Title: Ground Robotic Vehicle Mobility and Propulsion Technology</p> <p>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</p>		1.462	1.418	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / <i>Sensors and Electronic Survivability</i>	Project (Number/Name) TS2 / <i>Robotics Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
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.			
FY 2019 Plans: Explore novel mechanics and perception/proprioception technology to enable robust, resilient, and self-sustaining mobility of ground vehicle platforms. Research will be conducted in embedded and inherent sensing, actuation, control of complex structural dynamics, and cognitive/perceptual architectures. Embedded and inherent sensing will also be investigated as a technique to enable locally-controlled reflexive and intuitive behaviors.			
FY 2019 to FY 2020 Increase/Decrease Statement: FY 2020 funds realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BF8 (Artificial Intelligence & Machine Learning Tech) as part of financial restructure ins support of Army Modernization Priorities.			
Title: FY 2019 SBIR / STTR Transfer Description: FY 2019 SBIR / STTR Transfer	-	0.300	-
FY 2019 Plans: FY 2019 SBIR / STTR Transfer FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer			
Accomplishments/Planned Programs Subtotals	9.777	9.435	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602122A / TRACTOR HIP
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	8.627	8.674	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	17.301
622: D622	-	3.823	3.840	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	7.663
B72: AB72	-	4.804	4.834	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	9.638

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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	8.627	8.674	9.319	-	9.319
Current President's Budget	8.627	8.674	0.000	-	0.000
Total Adjustments	0.000	0.000	-9.319	-	-9.319
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	-9.319	-	-9.319

Change Summary Explanation

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

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602122A / TRACTOR HIP				Project (Number/Name) 622 / D622			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
622: D622	-	3.823	3.840	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	7.663

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).

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602122A / TRACTOR HIP				Project (Number/Name) B72 / AB72			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
B72: AB72	-	4.804	4.834	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	9.638

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).

UNCLASSIFIED

Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602126A / <i>TRACTOR JACK</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	0.000	0.400	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	0.400
XW8: <i>TRACTOR JACK</i>	-	0.000	0.400	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)

	<u>FY 2018</u>	<u>FY 2019</u>	<u>FY 2020 Base</u>	<u>FY 2020 OCO</u>	<u>FY 2020 Total</u>
Previous President's Budget	0.000	0.400	0.400	-	0.400
Current President's Budget	0.000	0.400	0.000	-	0.000
Total Adjustments	0.000	0.000	-0.400	-	-0.400
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	-0.400	-	-0.400

Change Summary Explanation

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

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602141A / <i>Lethality Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	0.000	0.000	26.961	-	26.961	30.215	35.294	36.309	36.155	0.000	164.934
AH5: <i>Projectile and Multi-Function Warhead Technologies</i>	-	0.000	0.000	3.446	-	3.446	3.515	3.585	3.657	3.698	0.000	17.901
AH6: <i>Disruptive Energetics and Propulsion Technologies</i>	-	0.000	0.000	8.275	-	8.275	8.441	8.610	8.783	8.882	0.000	42.991
AH7: <i>Lethal and Scalable Effects Technologies</i>	-	0.000	0.000	1.869	-	1.869	1.058	1.956	2.005	2.037	0.000	8.925
AH8: <i>Lethality Materials and Processes Technology</i>	-	0.000	0.000	3.954	-	3.954	4.050	4.113	4.030	4.075	0.000	20.222
AH9: <i>Advanced Warheads Technology</i>	-	0.000	0.000	9.417	-	9.417	10.918	12.370	12.617	12.757	0.000	58.079
AI1: <i>Advanced Terrain Shaping Technology*</i>	-	0.000	0.000	0.000	-	0.000	0.000	3.060	3.121	3.155	0.000	9.336
AI2: <i>Rapid Risk Analysis of Fires Technology*</i>	-	0.000	0.000	0.000	-	0.000	2.233	1.600	2.096	1.551	0.000	7.480

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

Note

In Fiscal Year (FY) 2020, funding in this Program Element (PE) is being 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).

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602141A / <i>Lethality Technology</i>
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Work in this effort complements PEs 0602143A (Soldier Lethality Technology), 0602144A (Ground Technology), 0602145A (Next Generation Combat Vehicle Technology), and 0602147A (Long Range Precision Fires 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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	0.000	0.000	0.000	-	0.000
Current President's Budget	0.000	0.000	26.961	-	26.961
Total Adjustments	0.000	0.000	26.961	-	26.961
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	26.961	-	26.961

Change Summary Explanation

FY20 increase related to Science and Technology financial restructuring.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602141A / <i>Lethality Technology</i>				Project (Number/Name) AH5 / <i>Projectile and Multi-Function Warhead Technologies</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AH5: <i>Projectile and Multi-Function Warhead Technologies</i>	-	0.000	0.000	3.446	-	3.446	3.515	3.585	3.657	3.698	0.000	17.901

Note

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

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 (ALAS-MC) Advanced Technology) and builds upon weapon target interaction research in PE 0601102A Defense Research Sciences / Project AA7 (Mechanics and Ballistics).

The cited work is consistent with 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 2018	FY 2019	FY 2020
Title: Defeat of Adversary Vehicle Armors	-	-	2.297
Description: This effort designs, models and evaluates longer range, higher velocity munitions through reduction of parasitic mass required to launch and deliver lethality via new composite materials and architecture; Develops higher energy, more lethal cannon (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 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602141A / <i>Lethality Technology</i>	Project (Number/Name) AH5 / <i>Projectile and Multi-Function Warhead Technologies</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
FY 2020 funds realigned from PE/Project 0602618A (Ballistics Technology) / H80 (Survivability and Lethality Technology) as part of financial restructure.			
<p>Title: Defeat of Adversary Body Armor</p> <p>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).</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: FY 2020 funds realigned from PE/Project 0602618A (Ballistics Technology) / H80 (Survivability and Lethality Technology) as part of financial restructure.</p>	-	-	1.149
Accomplishments/Planned Programs Subtotals	-	-	3.446

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602141A / <i>Lethality Technology</i>	Project (Number/Name) AH6 / <i>Disruptive Energetics and Propulsion Technologies</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AH6: <i>Disruptive Energetics and Propulsion Technologies</i>	-	0.000	0.000	8.275	-	8.275	8.441	8.610	8.783	8.882	0.000	42.991

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 2018	FY 2019	FY 2020
Title: Synthesis, Formulation and Diagnostics of Energetic Materials	-	-	4.953
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)			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602141A / <i>Lethality Technology</i>	Project (Number/Name) AH6 / <i>Disruptive Energetics and Propulsion Technologies</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
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 2019 to FY 2020 Increase/Decrease Statement: FY 2020 funds realigned from PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) as part of financial restructure.				
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 2019 to FY 2020 Increase/Decrease Statement: FY 2020 funds realigned from PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) as part of financial restructure.		-	-	1.752
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: 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 FY 2019 to FY 2020 Increase/Decrease Statement: FY 2020 funds realigned from PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) as part of financial restructure.		-	-	1.570
Accomplishments/Planned Programs Subtotals		-	-	8.275

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602141A / <i>Lethality Technology</i>	Project (Number/Name) AH6 / <i>Disruptive Energetics and Propulsion Technologies</i>

C. Other Program Funding Summary (\$ in Millions)
N/A

Remarks

D. Acquisition Strategy
N/A

E. Performance Metrics
N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602141A / <i>Lethality Technology</i>	Project (Number/Name) AH7 / <i>Lethal and Scalable Effects Technologies</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>AH7: Lethal and Scalable Effects Technologies</i>	-	0.000	0.000	1.869	-	1.869	1.058	1.956	2.005	2.037	0.000	8.925

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 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 2018	FY 2019	FY 2020
Title: Munition Efficiency and Scalability	-	-	1.869
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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602141A / <i>Lethality Technology</i>	Project (Number/Name) AH7 / <i>Lethal and Scalable Effects Technologies</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
upon FY19 progress to evaluate methodologies for tailored warhead delivery. Demonstrate preprogrammed, predefined pattern delivery of three warheads. FY 2019 to FY 2020 Increase/Decrease Statement: FY 2020 funds realigned from PE/Project 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) as part of the financial restructure.				
Accomplishments/Planned Programs Subtotals		-	-	1.869
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602141A / <i>Lethality Technology</i>				Project (Number/Name) AH8 / <i>Lethality Materials and Processes Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AH8: <i>Lethality Materials and Processes Technology</i>	-	0.000	0.000	3.954	-	3.954	4.050	4.113	4.030	4.075	0.000	20.222

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 Project AH6 (Disruptive Energetics and Propulsion Technology), Project AH7 (Lethal and Scalable Effects Technologies), 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)

Title: Materials for Advanced Lethality	FY 2018	FY 2019	FY 2020
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.	-	-	3.954
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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602141A / <i>Lethality Technology</i>	Project (Number/Name) AH8 / <i>Lethality Materials and Processes Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
(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).			
<i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> FY 2020 funds realigned from PE/Project 0602105A (Materials Technology) / H84 (Materials) as part of financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	3.954

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602141A / <i>Lethality Technology</i>				Project (Number/Name) AH9 / <i>Advanced Warheads Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AH9: <i>Advanced Warheads Technology</i>	-	0.000	0.000	9.417	-	9.417	10.918	12.370	12.617	12.757	0.000	58.079

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 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.

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 2018	FY 2019	FY 2020
Title: Materials for Advanced Lethality	-	-	9.417
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. 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 2019 to FY 2020 Increase/Decrease Statement: FY 2020 funds realigned from PE 0602624A (Weapons and Muniton Technology) / H28 (Warheads / Energetics Technologies) as part of financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	9.417

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army Date: March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602141A / <i>Lethality Technology</i>	Project (Number/Name) AH9 / <i>Advanced Warheads Technology</i>
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C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602142A / <i>Army Applied Research</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	0.000	0.000	25.319	-	25.319	25.467	24.119	23.918	23.696	0.000	122.519
BS1: <i>Army Applied Research</i>	-	0.000	0.000	25.319	-	25.319	25.467	24.119	23.918	23.696	0.000	122.519

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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	0.000	0.000	0.000	-	0.000
Current President's Budget	0.000	0.000	25.319	-	25.319
Total Adjustments	0.000	0.000	25.319	-	25.319
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	25.319	-	25.319

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army											Date: March 2019	
Appropriation/Budget Activity 2040: Research, Development, Test & Evaluation, Army / BA 2: Applied Research					R-1 Program Element (Number/Name) PE 0602143A / Soldier Lethality Technology							
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	0.000	0.000	115.274	-	115.274	126.345	136.958	140.057	141.390	0.000	660.024
AN1: <i>Narrowband SATCOM Technology</i>	-	0.000	0.000	4.000	-	4.000	1.000	0.000	0.000	0.000	0.000	5.000
AY6: <i>Soldier Squad Small Arms Armaments Technology</i>	-	0.000	0.000	18.345	-	18.345	18.316	17.577	14.988	15.145	0.000	84.371
AY8: <i>Small Arms Fire Control Technology*</i>	-	0.000	0.000	0.000	-	0.000	0.000	4.228	4.122	4.168	0.000	12.518
AZ2: <i>Body Armor & Integrated Headborne Technology</i>	-	0.000	0.000	8.427	-	8.427	8.081	8.753	8.928	9.027	0.000	43.216
AZ5: <i>Soldier Protection Technology - Vulnerability</i>	-	0.000	0.000	8.104	-	8.104	12.260	13.671	15.162	15.330	0.000	64.527
AZ9: <i>Soldier Protection Advanced Tech - Detectability</i>	-	0.000	0.000	4.500	-	4.500	5.294	7.181	6.883	6.964	0.000	30.822
BB4: <i>Dismounted Soldier Survivability Materials</i>	-	0.000	0.000	4.946	-	4.946	3.946	5.187	5.539	5.615	0.000	25.233
BB5: <i>Physical Augmentation: Tech for Human Interactions</i>	-	0.000	0.000	1.500	-	1.500	1.500	1.500	1.500	1.517	0.000	7.517
BB7: <i>Exoskeleton: Technology for Man-Machine Interface</i>	-	0.000	0.000	1.600	-	1.600	1.600	1.632	0.000	0.000	0.000	4.832
BB9: <i>Human Performance Tech for Mobility & Lethality</i>	-	0.000	0.000	2.500	-	2.500	1.500	1.000	0.000	0.000	0.000	5.000
BC2: <i>Next Gen Mobility & Lethality Tech for Warfighters</i>	-	0.000	0.000	5.678	-	5.678	5.221	5.827	2.596	2.625	0.000	21.947
BC3: <i>Soldier Decision Making & Comms Performance Tech</i>	-	0.000	0.000	10.759	-	10.759	9.875	9.992	6.112	6.181	0.000	42.919
BC6: <i>Human Perf - Tech for Warfighter Enhancement</i>	-	0.000	0.000	2.676	-	2.676	2.826	3.395	1.419	1.377	0.000	11.693
BC7: <i>Training Technology (Other than STE)*</i>	-	0.000	0.000	0.000	-	0.000	9.174	11.881	13.306	13.465	0.000	47.826

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army											Date: March 2019		
Appropriation/Budget Activity					R-1 Program Element (Number/Name)								
2040: Research, Development, Test & Evaluation, Army / BA 2: Applied Research					PE 0602143A / Soldier Lethality Technology								
BD1: Adv Soldier Sensors/ Displays Tech for Dismounts	-	0.000	0.000	4.967	-	4.967	5.085	5.208	18.286	18.490	0.000	52.036	
BD6: Soldier Sys Interfaces/ Integration- Sensor Tech	-	0.000	0.000	1.124	-	1.124	1.120	0.921	0.967	0.797	0.000	4.929	
BD8: Soldier & Sm Unit Tactical Energy Tech	-	0.000	0.000	9.145	-	9.145	9.052	9.162	11.434	11.585	0.000	50.378	
BE1: Support Technology to Mission Command	-	0.000	0.000	0.726	-	0.726	0.908	0.900	0.900	0.892	0.000	4.326	
BE3: Joint Service Combat Feeding Technology	-	0.000	0.000	3.996	-	3.996	4.713	4.677	4.768	8.439	0.000	26.593	
BE6: Reactive/Resp Surfaces & Mats-Soldiers & Sys	-	0.000	0.000	2.745	-	2.745	2.987	3.024	3.156	3.558	0.000	15.470	
BE8: Synthetic Training Environment (STE) Technology	-	0.000	0.000	15.438	-	15.438	18.159	17.720	16.036	16.215	0.000	83.568	
BR9: Personnel & Airdrop Safety Technology	-	0.000	0.000	4.098	-	4.098	3.728	3.522	3.955	0.000	0.000	15.303	

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

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is realigned with continuity of effort from the following PEs:

- * 0602105A Materials Technology
- * 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 Countermining Systems
- * 0602716A Human Factors Engineering Technology
- * 0602786A Warfighter Technology

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	
A. Mission Description and Budget Item Justification <p>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.</p> <p>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 Army Test and Evaluation Command (ATEC).</p> <p>Work in this PE complements PE 0603118A, Soldier Lethality Advanced Technology.</p> <p>There are no new starts in this Program Element.</p> <p>All FY 2020 adjustments align program financial structure to Army Modernization Priorities in support of the National Defense Strategy.</p> <p>Work in this Project is performed by the United States Army Futures Command (AFC).</p>		

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>
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B. Program Change Summary (\$ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	0.000	0.000	0.000	-	0.000
Current President's Budget	0.000	0.000	115.274	-	115.274
Total Adjustments	0.000	0.000	115.274	-	115.274
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	115.274	-	115.274

Change Summary Explanation

FY20 increase related to Science and Technology financial restructuring.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>				Project (Number/Name) AN1 / <i>Narrowband SATCOM Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AN1: <i>Narrowband SATCOM Technology</i>	-	0.000	0.000	4.000	-	4.000	1.000	0.000	0.000	0.000	0.000	5.000

Note
 In Fiscal Year (FY) 2020 this Project is realigned from:
 Program Element (PE) 0602782A Command, Control, Communications Technology Project:
 * Project H92 Communications 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. Fiscal Year (FY) 2020 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 2018	FY 2019	FY 2020
Title: Narrowband Satellite Communication Technology	-	-	4.000
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: Will 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 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) AN1 / <i>Narrowband SATCOM Technology</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort is realigned from PE 0602782A (Command, Control, Communications Technology) / Project H92 (Communications Technology) in FY 2020 as part of the financial restructure, and supports the Army's Modernization Priorities.			
Accomplishments/Planned Programs Subtotals	-	-	4.000

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>				Project (Number/Name) AY6 / <i>Soldier Squad Small Arms Armaments Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AY6: <i>Soldier Squad Small Arms Armaments Technology</i>	-	0.000	0.000	18.345	-	18.345	18.316	17.577	14.988	15.145	0.000	84.371

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.

FY 2020 realignments are due to financial restructuring in support of Army Modernization Priorities.

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

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Soldier/Squad Lethality Technology	FY 2018	FY 2019	FY 2020
	-	-	2.239

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) AY6 / <i>Soldier Squad Small Arms Armaments Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Description: This effort conceives, investigates and demonstrates 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.</p> <p>FY 2020 Plans: Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort 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), and PE 0602716A (Human Factors Engineering Technology) / Project H70 (Human Factors Engineering System Development) in FY 2020.</p>				
<p>Title: Human-Agent Interactions for Intelligent Squad Weapons</p> <p>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.</p> <p>FY 2020 Plans: Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort 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), and PE 0602716A (Human Factors Engineering Technology) / Project H70 (Human Factors Engineering System Development) in FY 2020.</p>		-	-	3.575
<p>Title: Next Generation Carbine Technology (NGCT)</p> <p>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</p>		-	-	1.500

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) AY6 / <i>Soldier Squad Small Arms Armaments Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2020 Plans: Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort 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), and PE 0602716A (Human Factors Engineering Technology) / Project H70 (Human Factors Engineering System Development) in FY 2020.</p>				
<p>Title: Next Generation Family of Ammo (NGFoA)</p> <p>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; develop capabilities to defeat threat targets out to 600 meters.</p> <p>FY 2020 Plans: Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort 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), and PE 0602716A (Human Factors Engineering Technology) / Project H70 (Human Factors Engineering System Development) in FY 2020.</p>		-	-	6.500
<p>Title: Small Arms Enabling Technologies</p> <p>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.</p> <p>FY 2020 Plans:</p>		-	-	4.531

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) AY6 / <i>Soldier Squad Small Arms Armaments Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Will 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.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort 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), and PE 0602716A (Human Factors Engineering Technology) / Project H70 (Human Factors Engineering System Development) in FY 2020.</p>				
Accomplishments/Planned Programs Subtotals		-	-	18.345
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				
E. Performance Metrics				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) AZ2 / <i>Body Armor & Integrated Headborne Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>AZ2: Body Armor & Integrated Headborne Technology</i>	-	0.000	0.000	8.427	-	8.427	8.081	8.753	8.928	9.027	0.000	43.216

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.

FY 2020 realignments are due to financial restructuring in support of Army Modernization Priorities.

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

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Body Armor & Integrated Headborne Technology	-	-	8.427
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: Will 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, will 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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) AZ2 / <i>Body Armor & Integrated Headborne Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
performance of head-borne equipment in a simulated near free-field blast overpressure environment; will 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 of head injury criteria to inform future helmet performance and injury biomechanics; will systematically investigate material composite pre-stress processing methods to increase ballistic material mechanical properties during composite laminate processing to enhance ballistic performance. <i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602786A (Warfighter Technology) / Project H98 (Clothing & Equipm Tech) in FY20 as part of the financial restructure..			
Accomplishments/Planned Programs Subtotals	-	-	8.427

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>				Project (Number/Name) AZ5 / <i>Soldier Protection Technology - Vulnerability</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>AZ5: Soldier Protection Technology - Vulnerability</i>	-	0.000	0.000	8.104	-	8.104	12.260	13.671	15.162	15.330	0.000	64.527

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.

FY 2020 realignments are due to financial restructuring in support of Army Modernization Priorities.

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

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Soldier Protection Technologies	FY 2018	FY 2019	FY 2020
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	-	-	4.131

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) AZ5 / <i>Soldier Protection Technology - Vulnerability</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>fiber solutions for backing materials to deliver soldier protection systems to meet emerging ballistic and signature management threats. This effort supports small caliber lethal mechanisms research in PE 0602143A (Soldier Lethality Technology) / Project AY6 (Soldier Squad Small Arms Armaments Technology).</p> <p>FY 2020 Plans: Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602105A (Materials Technology) / Project H84 (Materials) and PE 0602618A (Ballistics Technology) / Project H80 (Survivability And Lethality Technology) in FY 2020 as part of the financial restructure.</p>				
<p>Title: Soldier-Borne Composite Materials</p> <p>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.</p> <p>FY 2020 Plans: Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602105A (Materials Technology) / Project H84 (Materials) and PE 0602618A (Ballistics Technology) / Project H80 (Survivability And Lethality Technology) in FY 2020 as part of the financial restructure.</p>		-	-	2.679
<p>Title: Soldier-Borne Advanced Protection Materials</p> <p>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</p>		-	-	1.294

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) AZ5 / <i>Soldier Protection Technology - Vulnerability</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
lethal mechanisms research in PE 0602143A (Soldier Lethality Technology) / Project AY6 (Soldier Squad Small Arms Armaments Technology),			
<i>FY 2020 Plans:</i> Will 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.			
<i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602105A (Materials Technology) / Project H84 (Materials) and PE 0602618A (Ballistics Technology) / Project H80 (Survivability And Lethality Technology) in FY 2020 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	8.104

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>				Project (Number/Name) AZ9 / <i>Soldier Protection Advanced Tech - Detectability</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>AZ9: Soldier Protection Advanced Tech - Detectability</i>	-	0.000	0.000	4.500	-	4.500	5.294	7.181	6.883	6.964	0.000	30.822

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 (Countermining 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.

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 2018	FY 2019	FY 2020
Title: Camouflage, Concealment and Decoys Technologies for Soldier and High-Value Assets	-	-	4.500
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)			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) AZ9 / <i>Soldier Protection Advanced Tech - Detectability</i>

B. Accomplishments/Planned Programs (\$ in Millions)

<p>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 capability gap between current camouflage, concealment, and deception technologies and defeating enemy sensorial capabilities in future operating environments.</p> <p>FY 2020 Plans: Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602786A (Warfighter Technology) / Project H98 (Clothing & Equipm Tech) in FY 2020 as part of financial restructure.</p>	FY 2018	FY 2019	FY 2020
	Accomplishments/Planned Programs Subtotals	-	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>				Project (Number/Name) BB4 / <i>Dismounted Soldier Survivability Materials</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BB4: <i>Dismounted Soldier Survivability Materials</i>	-	0.000	0.000	4.946	-	4.946	3.946	5.187	5.539	5.615	0.000	25.233

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.

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)

Title: Dismounted Soldier Survivability Materials	FY 2018	FY 2019	FY 2020
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 multifunctional 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	-	-	4.946

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) BB4 / <i>Dismounted Soldier Survivability Materials</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
that enable extended dismounted mission durations by reducing the demand for water resupply and enabling squad organic water filtration systems.			
<i>FY 2020 Plans:</i> Will 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.			
<i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602786A (Warfighter Technology) / Project H98 (Clothing and Equipment Technologies) in FY 2020 as part of the financial structure.			
Accomplishments/Planned Programs Subtotals	-	-	4.946

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) BB5 / <i>Physical Augmentation: Tech for Human Interactions</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>BB5: Physical Augmentation: Tech for Human Interactions</i>	-	0.000	0.000	1.500	-	1.500	1.500	1.500	1.500	1.517	0.000	7.517

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), and Project BC6 (Human Perf - Tech for Warfighter Enhancement) 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 Materiel 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.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) BB5 / <i>Physical Augmentation: Tech for Human Interactions</i>
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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 2018	FY 2019	FY 2020
<p>Title: Training Adaptation and Movement Science</p> <p>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.</p> <p>FY 2020 Plans: Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602786A (Warfighter Technology) / Project H98 (Clothing and Equipm Tech, and PE 0602716A Human Factors Engineering Technology /Project H70 (Human Fact Eng Sys Dev) in FY 2020 as part of the financial restructure.</p>	-	-	1.500
Accomplishments/Planned Programs Subtotals	-	-	1.500

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>				Project (Number/Name) BB7 / <i>Exoskeleton: Technology for Man-Machine Interface</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>BB7: Exoskeleton: Technology for Man-Machine Interface</i>	-	0.000	0.000	1.600	-	1.600	1.600	1.632	0.000	0.000	0.000	4.832

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 are transitioned to the Research, Development, and Engineering Centers, Program Executive Offices (PEO), 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.

FY 2020 realignments are due to financial restructuring in support of Army Modernization Priorities.

Work in this Project is performed by the U.S. Army Futures Command (AFC).

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Exoskeleton	-	-	1.600
Description: This effort will accelerate Soldier lifting and mobility capabilities through exoskeleton systems with improved safety and reduced training requirements.			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) BB7 / <i>Exoskeleton: Technology for Man-Machine Interface</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p><i>FY 2020 Plans:</i> Will 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.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602716A (Human Factors Engineering Technology) / Project H70 (Human Fact Eng Sys Dev) in FY 2020 as part of the financial restructure.</p>			
Accomplishments/Planned Programs Subtotals	-	-	1.600

C. Other Program Funding Summary (\$ in Millions)
N/A

Remarks

D. Acquisition Strategy
N/A

E. Performance Metrics
N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>				Project (Number/Name) BB9 / <i>Human Performance Tech for Mobility & Lethality</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BB9: <i>Human Performance Tech for Mobility & Lethality</i>	-	0.000	0.000	2.500	-	2.500	1.500	1.000	0.000	0.000	0.000	5.000

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 Materiel Command under the Military Operational Medicine Research Program as well as Defense Medical Research and Development Program under Military Operational Medicine (JPC-5). 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 and the Army Modernization Strategy, as well as the Office of the Secretary of Defense 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)

Title: Human Interaction for Situational Understanding	FY 2018	FY 2019	FY 2020
	-	-	2.500

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) BB9 / <i>Human Performance Tech for Mobility & Lethality</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>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 conduct experiments to populate performance models that have application across materiel and non-materiel solutions.</p> <p>FY 2020 Plans: Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602786A (Warfighter Technology) / Project H98 (Clothing and Equipm Tech) in FY 2020 as part of the financial structure.</p>			
Accomplishments/Planned Programs Subtotals	-	-	2.500

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) BC2 / <i>Next Gen Mobility & Lethality Tech for Warfighters</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>BC2: Next Gen Mobility & Lethality Tech for Warfighters</i>	-	0.000	0.000	5.678	-	5.678	5.221	5.827	2.596	2.625	0.000	21.947

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.

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), Project BC2 (Next Gen Mobility & Lethality Tech for Warfighters), 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), and 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 Materiel Command under the Military Operational Medicine Research Program as well as Defense Medical Research and Development Program under Military Operational Medicine (JPC-5). 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 and the Army Modernization Strategy, as well as the Office of the Secretary of Defense 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).

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) BC2 / <i>Next Gen Mobility & Lethality Tech for Warfighters</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>Title: Human Interaction for Mobility & Lethality</p> <p>Description: This effort investigates and develops human performance based design guidance for protection and weapon systems and sub systems to enable 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.</p> <p>FY 2020 Plans: Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602786A (Warfighter Technology) / Project H98 Clothing and Equipm Tech) in FY 2020 as part of the financial restructure.</p>	-	-	5.678
Accomplishments/Planned Programs Subtotals	-	-	5.678

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) BC3 / <i>Soldier Decision Making & Comms Performance Tech</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BC3: <i>Soldier Decision Making & Comms Performance Tech</i>	-	0.000	0.000	10.759	-	10.759	9.875	9.992	6.112	6.181	0.000	42.919

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 on Cyber Electromagnetic (CEMA) threat and friendly/coalition counter CEMA efforts as well as human behavior variables that influence CEMA operations and the outcomes of CEMA attacks. The resulting outcomes create analytical and empirical capabilities to characterize, model, and forecast human behavior related to CEMA 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 CEMA 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 addresses Army gaps and needed capabilities by conducting cyber cognition and teaming assessments as well as studying human behaviors in CEMA-physical environments, attacker-defender-user dynamics, and Soldier-system integration challenges that underlie forces ability to converge kinetic, cyber and electromagnetic activities. Results will inform technology selection and development, training assessments, system specifications, and operational planning.

Results of these efforts are transitioned to Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) Program Managers, 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, as well as the Office of the Secretary of Defense Close Combat Lethality Task Force.

FY 2020 realignments are due to financial restructuring in support of Army Modernization Priorities.

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

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Soldier Performance in Sociotechnical Environments	FY 2018	FY 2019	FY 2020
	-	-	10.759

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) BC3 / <i>Soldier Decision Making & Comms Performance Tech</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>Description: This effort directly supports the Army's Network/C3I and Soldier Lethality modernization priority by enabling effective human performance in distributed network-enabled and Cyber Mission Force operations. The research provides human cyber operations assessment and advanced human decision-support capabilities required by our transition partners Communications and Electronics Research Development and Engineering Command (CERDEC) and Cyber Command (CYBERCOM) to deploy cyber work systems that optimize human-machine interactions and account for operator and adversary behavior. Without 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.</p> <p>FY 2020 Plans: Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This this research effort was realigned from PE 0602716A (Human Factors Engineering Technology) /Project H70 Human Fact Eng Sys Dev) and PE 0602308 (Advanced Concepts and Simulation) / Project C90 Advanced Distributed Simulation) in FY 2020 as part of the financial structure.</p>			
Accomplishments/Planned Programs Subtotals	-	-	10.759

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) BC6 / <i>Human Perf - Tech for Warfighter Enhancement</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>BC6: Human Perf - Tech for Warfighter Enhancement</i>	-	0.000	0.000	2.676	-	2.676	2.826	3.395	1.419	1.377	0.000	11.693

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 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), 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 Materiel Command under the Military Operational Medicine Research Program as well as Defense Medical Research and Development Program under Military Operational Medicine (JPC-5). 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 Army Research Laboratory (ARL).

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

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) BC6 / <i>Human Perf - Tech for Warfighter Enhancement</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>Title: Human Performance Technology for Warfighter Enhancement</p> <p>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.</p> <p>FY 2020 Plans: Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602786A (Warfighter Technology) / Project H98 (Clothing and Equipm Tech) in FY 2020 as part of the financial restructure.</p>	-	-	2.676
Accomplishments/Planned Programs Subtotals	-	-	2.676

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>				Project (Number/Name) BD1 / <i>Adv Soldier Sensors/Displays Tech for Dismounts</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BD1: <i>Adv Soldier Sensors/Displays Tech for Dismounts</i>	-	0.000	0.000	4.967	-	4.967	5.085	5.208	18.286	18.490	0.000	52.036

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 Countermines Systems
 * Project H24 Countermines 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.

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)

Title: Advanced Soldier Sensors/Displays Technology for Dismounts	FY 2018	FY 2019	FY 2020
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).	-	-	4.967
FY 2020 Plans:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) BD1 / <i>Adv Soldier Sensors/Displays Tech for Dismounts</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>Will 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 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.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602709A (Night Vision Technology) / Project H95 (Night Vision And Electro-Optic Technology), and PE 0602712A Countermine Systems /Project H24 (Countermine Tech in FY20 as part of the financial restructure.</p>			
Accomplishments/Planned Programs Subtotals	-	-	4.967

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>				Project (Number/Name) BD6 / <i>Soldier Sys Interfaces/Integration-Sensor Tech</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BD6: <i>Soldier Sys Interfaces/Integration- Sensor Tech</i>	-	0.000	0.000	1.124	-	1.124	1.120	0.921	0.967	0.797	0.000	4.929

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.

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Soldier System Interfaces & Integration (Sensor Technology)	FY 2018	FY 2019	FY 2020
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.	-	-	1.124
FY 2020 Plans:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) BD6 / <i>Soldier Sys Interfaces/Integration-Sensor Tech</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
Will 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 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. <i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602786A (Warfighter Technology) / Project H98 Clothing and Equipm Tech in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	1.124

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>				Project (Number/Name) BD8 / <i>Soldier & Sm Unit Tactical Energy Tech</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BD8: <i>Soldier & Sm Unit Tactical Energy Tech</i>	-	0.000	0.000	9.145	-	9.145	9.052	9.162	11.434	11.585	0.000	50.378

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.

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Tactical Power for Soldier Lethality	-	-	3.900
Description: This effort investigates, designs and develops innovative materials and component level power generation and energy storages technologies that support next generation weapons, sensors, radios and human augmentation devices to enable 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: Will 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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) BD8 / <i>Soldier & Sm Unit Tactical Energy Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>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 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602705A (Electronics and Electronic Devices) / Project H11 (Tactical and Component Power Technology), and Project H94 (Elec & Electronic Devices) as part of the financial restructure.</p>				
<p>Title: Materials & Component Technologies for Energy Independence</p> <p>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.</p> <p>FY 2020 Plans: Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602705A (Electronics and Electronic Devices) / Project H11 (Tactical and Component Power Technology), and Project H94 (Elec & Electronic Devices) as part of the financial restructure.</p>		-	-	5.245
Accomplishments/Planned Programs Subtotals		-	-	9.145
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) BD8 / <i>Soldier & Sm Unit Tactical Energy Tech</i>

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>				Project (Number/Name) BE1 / <i>Support Technology to Mission Command</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BE1: <i>Support Technology to Mission Command</i>	-	0.000	0.000	0.726	-	0.726	0.908	0.900	0.900	0.892	0.000	4.326

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 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 (Countermining 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.

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Small Unit Expeditionary Mission Command Research	-	-	0.726
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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) BE1 / <i>Support Technology to Mission Command</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>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.</p> <p><i>FY 2020 Plans:</i> Will 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.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602786A (Warfighter Technology) / Project XW5 (Small Unit Expeditionary Maneuver Technology) FY20 as part of the financial restructure.</p>				
Accomplishments/Planned Programs Subtotals		-	-	0.726
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				
E. Performance Metrics				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>				Project (Number/Name) BE3 / <i>Joint Service Combat Feeding Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BE3: <i>Joint Service Combat Feeding Technology</i>	-	0.000	0.000	3.996	-	3.996	4.713	4.677	4.768	8.439	0.000	26.593

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.

In FY20, 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 (3D Printing) 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 area; 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.

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Joint Service Combat Feeding Technology	FY 2018	FY 2019	FY 2020
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	-	-	3.996

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) BE3 / <i>Joint Service Combat Feeding Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
to reduce resupply requirements. Work in this area results in increased performance, less food-borne illness, and overall increased readiness of the warfighter.				
FY 2020 Plans: Will 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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602786A (Warfighter Technology) / Project H99 (Joint Service Combat Feeding Technology) in FY20 as part of the financial restructure.				
Accomplishments/Planned Programs Subtotals		-	-	3.996
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>				Project (Number/Name) BE6 / <i>Reactive/Resp Surfaces & Mats-Soldiers & Sys</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>BE6: Reactive/Resp Surfaces & Mats-Soldiers & Sys</i>	-	0.000	0.000	2.745	-	2.745	2.987	3.024	3.156	3.558	0.000	15.470

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 evaluates 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 H57 (Single Investigator Basic Research), Project H42: (Materials & Mechanics), and Project AA5 (Biotechnology and Systems Biology).

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)

Title: Bio-enabled Materials and Processes	FY 2018	FY 2019	FY 2020
Description: The effort conducts 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. Investment in Bio-enabled materials research allows the design of materials that are capable of sensing and responding, as well as adapting to a broad spectrum of environmental variables with ability to self-monitor, self-heal and self-sustain. Investments in this area could lead	-	-	2.745

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) BE6 / <i>Reactive/Resp Surfaces & Mats-Soldiers & Sys</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
to future applications in Solider performance, situational awareness, protection and sustainment. Research from this effort has potential to transition to multiple end items and applications.			
<i>FY 2020 Plans:</i> Will 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.			
<i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602105A (Materials Technology) /Project H84 (Materials) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	2.745

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>				Project (Number/Name) BE8 / <i>Synthetic Training Environment (STE) Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BE8: <i>Synthetic Training Environment (STE) Technology</i>	-	0.000	0.000	15.438	-	15.438	18.159	17.720	16.036	16.215	0.000	83.568

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 investigates and develops technologies supporting the Army's Synthetic Training Environment (STE) priority, a comprehensive live-virtual-constructive architecture that will enable Soldiers to train the spectrum of missions in virtual environments involving thousands of virtual combatants and miles of complex terrain including megacities. The STE will enable Army units and leaders to conduct realistic multi-echelon / Multi-Domain Operations, combined arms maneuver, and mission command training at the point of need anywhere in the world, increasing Soldier and Small Unit proficiency through repetition. Units can then master collective training tasks in the live environment.

This Project investigates and designs STE enabling technologies to include networking of models representing complex human behavior, complex data interchange between simulations, synthetic natural environments, virtual representation of combined arms environments, adaptive tutoring for individuals and teams, and collaborative training.

Project efforts include techniques and methods for integrating different sensory cues into virtual environments that result in enhanced training and leader development and the design of virtual humans utilizing Artificial Intelligence (AI) enabled attributes that embody natural language, speech recognition in noisy environments, gesture, gaze, and conversational speech and other complex human tasks.

The Project leverages the capabilities of industry and the research and development community through the synthesis of creativity and technology, including work conducted at the Institute for Creative Technologies (ICT).

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

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

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) BE8 / <i>Synthetic Training Environment (STE) Technology</i>

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

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>Title: Innovative Synthetic Training Technology</p> <p>Description: This effort investigates and designs methods of applying Artificial Intelligence into the STE in order to simulate a fully immersive environment in large urban settings with a population of adaptable, noncombatant virtual human agents to increase 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.</p> <p>FY 2020 Plans: Will 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. Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602308 (Advanced Concepts and Simulation) / Project C90 (Advanced Distributed Simulation) Project D02 Modeling & Simulation For Training And Design), PE 0602716A (Human Factors Engineering Technology) /Project H70 (Human Fact Eng Sys Dev) FY20 as part of the financial structure.</p>	-	-	8.078
<p>Title: STE One World Terrain</p> <p>Description: This effort investigates and designs tools and methods to improve the speed and fidelity of a terrain capability that provides a fully accessible representation of the globe, accessible through the Army network and usable by all simulation trainers; develop complex representations (including Megacities and Subterranean) of the Operational Environment and the Multi-Domain battlefield in synthetic training environments.</p> <p>FY 2020 Plans: Will 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</p>	-	-	2.168

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) BE8 / <i>Synthetic Training Environment (STE) Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602308 (Advanced Concepts and Simulation) / Project C90 (Advanced Distributed Simulation), Project D02 (Modeling & Simulation For Training And Design), PE 0602716A (Human Factors Engineering Technology) / (Project H70 Human Fact Eng Sys Dev in FY 20 as part of the financial restructure.				
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: Will 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. Will 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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602308 (Advanced Concepts and Simulation) / Project C90 (Advanced Distributed Simulation), Project D02 (Modeling & Simulation For Training And Design), PE 0602716A (Human Factors Engineering Technology) / (Project H70 Human Fact Eng Sys Dev in FY 20 as part of the financial restructure.		-	-	5.192
Accomplishments/Planned Programs Subtotals		-	-	15.438
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) BE8 / <i>Synthetic Training Environment (STE) Technology</i>

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>				Project (Number/Name) BR9 / <i>Personnel & Airdrop Safety Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BR9: <i>Personnel & Airdrop Safety Technology</i>	-	0.000	0.000	4.098	-	4.098	3.728	3.522	3.955	0.000	0.000	15.303

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. The U.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.

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 2018	FY 2019	FY 2020
Title: Personnel & Airdrop Safety Technology	-	-	4.098
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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602143A / <i>Soldier Lethality Technology</i>	Project (Number/Name) BR9 / <i>Personnel & Airdrop Safety Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>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 insertion safety requires to modernize the Airborne Soldier and provide the ability to effectively execute the airborne mission through reducing safety risk and increasing capabilities.</p> <p>FY 2020 Plans: Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602786A (Warfighter Technology) / Project XW5 (Small Unit Expeditionary Maneuver Technology) in FY20 as part of the financial restructure.</p>			
Accomplishments/Planned Programs Subtotals	-	-	4.098

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602144A / <i>Ground Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	0.000	0.000	35.199	-	35.199	29.837	31.647	30.220	27.700	0.000	154.603
BK7: <i>Robotics for Engineer Operations Technology</i>	-	0.000	0.000	9.998	-	9.998	6.271	3.246	2.433	1.770	0.000	23.718
BL1: <i>Materials and Manufacturing Research Technology</i>	-	0.000	0.000	8.127	-	8.127	10.280	10.509	10.828	10.953	0.000	50.697
BL2: <i>Explosives Forensics Technology</i>	-	0.000	0.000	1.542	-	1.542	1.573	1.604	1.636	1.655	0.000	8.010
BL4: <i>Countermines Technology</i>	-	0.000	0.000	4.244	-	4.244	4.369	4.497	0.000	0.000	0.000	13.110
BL5: <i>Expedient Passive Protection Technology</i>	-	0.000	0.000	4.119	-	4.119	1.468	2.432	5.953	5.110	0.000	19.082
BL7: <i>Power Projection in A2AD Environments Technology</i>	-	0.000	0.000	2.766	-	2.766	1.915	3.193	3.270	2.875	0.000	14.019
BL9: <i>Protection from Advanced Weapon Effects Technology</i>	-	0.000	0.000	4.403	-	4.403	3.961	6.166	6.100	5.337	0.000	25.967

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 Countermines Systems
- * 0602720A Environmental Quality Technology
- * 0602784A Military Engineering 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. This PE designs and validates technologies that are necessary and foundational for legacy and future ground movement, maneuver and protection of Soldiers.

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

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602144A / <i>Ground Technology</i>
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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 U.S. Army Futures Command and the United States Army Engineer Research and Development Center.

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

B. Program Change Summary (\$ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	0.000	0.000	0.000	-	0.000
Current President's Budget	0.000	0.000	35.199	-	35.199
Total Adjustments	0.000	0.000	35.199	-	35.199
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	35.199	-	35.199

Change Summary Explanation

FY20 increase related to science and technology financial restructuring.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602144A / <i>Ground Technology</i>				Project (Number/Name) BK7 / <i>Robotics for Engineer Operations Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>BK7: Robotics for Engineer Operations Technology</i>	-	0.000	0.000	9.998	-	9.998	6.271	3.246	2.433	1.770	0.000	23.718

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.

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 Portfolio.

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 Engineer Research and Development Center.

This effort is coordinated with PE 0603462A (NGCV Advanced Technology).

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Dynamic Site Characterization	-	-	2.172

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / <i>Ground Technology</i>	Project (Number/Name) BK7 / <i>Robotics for Engineer Operations Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2020 Plans: Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602784A (Military Engineering Technology) / Projects T41 (Mil Facilities Eng Tech) and T45 (Energy Tec Apl Mil Fac) and PE0602720A (Environmental Quality Technology) / Project 048 (Ind Oper Poll Ctrl Tec) in FY 2020 as part of the financial restructure in support of Army Modernization Priorities.</p>				
<p>Title: Mission Planning and Task Execution Control</p> <p>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.</p> <p>FY 2020 Plans: Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602784A (Military Engineering Technology) / Projects T41 (Mil Facilities Eng Tech) and T45 (Energy Tec Apl Mil Fac) and PE0602720A (Environmental Quality Technology) / Project 048 (Ind Oper Poll Ctrl Tec) in FY20 as part of the financial restructure in support of Army Modernization Priorities.</p>		-	-	3.172
<p>Title: Integration Prototype Model Development</p> <p>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.</p> <p>FY 2020 Plans:</p>		-	-	4.654

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / <i>Ground Technology</i>	Project (Number/Name) BK7 / <i>Robotics for Engineer Operations Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
Will 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.			
<i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602784A (Military Engineering Technology) / Projects T41 (Mil Facilities Eng Tech) and T45 (Energy Tec Apl Mil Fac) and PE0602720A (Environmental Quality Technology) / Project 048 (Ind Oper Poll Ctrl Tec) in FY 2020 as part of the financial restructure in support of Army Modernization Priorities.			
Accomplishments/Planned Programs Subtotals	-	-	9.998

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / <i>Ground Technology</i>	Project (Number/Name) BL1 / <i>Materials and Manufacturing Research Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BL1: <i>Materials and Manufacturing Research Technology</i>	-	0.000	0.000	8.127	-	8.127	10.280	10.509	10.828	10.953	0.000	50.697

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 Portfolio.

Work is performed by the U.S. Army Futures Command.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Agile Expedient Manufacturing	-	-	2.350
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 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,			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / <i>Ground Technology</i>	Project (Number/Name) BL1 / <i>Materials and Manufacturing Research Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>properties, and performance to enable the design and production of optimal materials at the point of need using available materials, energy sources, etc.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602105A (Materials Technology) / Project XW4 (Manufacturing Science) and PE 0602705A (Electronics and Electronic Devices) / Project H94 (Electronics and Electronic Devices) in FY 2020 as part of the financial restructure in support of Army Modernization Priorities.</p>				
<p>Title: Power and Energy</p> <p>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.</p> <p>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 electrolyzers 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602105A (Materials Technology) / Project XW4 (Manufacturing Science) and PE 0602705A (Electronics and Electronic Devices) / Project H94 (Electronics and Electronic Devices) in FY 2020 as part of the financial restructure in support of Army Modernization Priorities.</p>		-	-	1.732
<p>Title: Additive Manufacturing Research</p>		-	-	4.045

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / <i>Ground Technology</i>	Project (Number/Name) BL1 / <i>Materials and Manufacturing Research Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>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 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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602105A (Materials Technology) / Project XW4 (Manufacturing Science) and PE 0602705A (Electronics and Electronic Devices) / Project H94 (Electronics and Electronic Devices) in FY 2020 as part of the financial restructure in support of Army Modernization Priorities.</p>				
Accomplishments/Planned Programs Subtotals		-	-	8.127
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				
E. Performance Metrics				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602144A / <i>Ground Technology</i>				Project (Number/Name) BL2 / <i>Explosives Forensics Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BL2: <i>Explosives Forensics Technology</i>	-	0.000	0.000	1.542	-	1.542	1.573	1.604	1.636	1.655	0.000	8.010

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. Project BL2 (Explosives Forensics Technology) 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 and Next Generation Combat Vehicle Portfolio.

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

Work in this Project is related to, and fully coordinated with PE 0603119A (Ground Advanced Technology), Project BL3 (Explosive Forensics Advanced Technology).

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Forensic Analysis of Explosives Signatures Applied Research	-	-	1.542
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 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / <i>Ground Technology</i>	Project (Number/Name) BL2 / <i>Explosives Forensics Technology</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602622A (Chemical, Smoke and Equipment Defeating Technology) / Project 552 (Smoke/Novel Effects Munitions) in FY20 as part of the financial restructure in support of Army Modernization Priorities.			
Accomplishments/Planned Programs Subtotals	-	-	1.542

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602144A / <i>Ground Technology</i>				Project (Number/Name) BL4 / <i>Countermine Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BL4: <i>Countermine Technology</i>	-	0.000	0.000	4.244	-	4.244	4.369	4.497	0.000	0.000	0.000	13.110

Note

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

A. Mission Description and Budget Item Justification

This Project designs and develops selectable explosive hazard (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 Next Generation Combat Vehicle, and Soldier Lethality modernization priorities.

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Countermine Technology	-	-	4.244
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:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / <i>Ground Technology</i>	Project (Number/Name) BL4 / <i>Countermine Technology</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
Will design EH neutralization techniques and set parameters of confirmation sensors; will mature laser, radio frequency and microwave sources to validate neutralization techniques.			
<i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602712A (Countermine Systems) / Project H24 (Selectable Neutralization and Breaching Technology) in FY 2020 as part of the financial restructure in support of Army Modernization Priorities.			
Accomplishments/Planned Programs Subtotals	-	-	4.244

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602144A / <i>Ground Technology</i>				Project (Number/Name) BL5 / <i>Expedient Passive Protection Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BL5: <i>Expedient Passive Protection Technology</i>	-	0.000	0.000	4.119	-	4.119	1.468	2.432	5.953	5.110	0.000	19.082

Note

In Fiscal Year (FY) 2020 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 evaluates technologies to design and develop 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 the complex, urban environment. This Project also develops expedient solutions and decision support applications for protection against advanced energetic threats and large caliber rockets and missiles.

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 Army Engineer Research and Development Center.

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

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Integrate Novel Materials for Tone Down Applications	-	-	0.337
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: Will 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. Will deliver suite of fully characterized			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / <i>Ground Technology</i>	Project (Number/Name) BL5 / <i>Expedient Passive Protection Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
formulations for use in unconventional countermeasures to include risk guidance on application hazards associated with material debris. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602720A (Environmental Quality Technology) / Project 835 (Military Materials in the Environment Research and Development) and PE 0602784A (Military Engineering Technology) / Project T40 (Mobility/Weapons Effects Technology) in FY20 as part of the financial restructure in support of Army Modernization Priorities.				
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; This effort 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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602720A (Environmental Quality Technology) / Project 835 (Military Materials in the Environment Research and Development) and PE 0602784A (Military Engineering Technology) / Project T40 (Mobility/Weapons Effects Technology) in FY20 as part of the financial restructure in support of Army Modernization Priorities.		-	-	3.782
Accomplishments/Planned Programs Subtotals		-	-	4.119
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602144A / <i>Ground Technology</i>				Project (Number/Name) BL7 / <i>Power Projection in A2AD Environments Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BL7: <i>Power Projection in A2AD Environments Technology</i>	-	0.000	0.000	2.766	-	2.766	1.915	3.193	3.270	2.875	0.000	14.019

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 performed by the United States Army Engineer Research and Development Center.

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

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Entry and Sustainment in Complex Contested Environments	-	-	2.766
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: Will conduct experiments on engineering properties of ice and snow to investigate remote sensing technologies for off-road mobility in extreme environments; will explore Light Detection and Ranging and photogrammetric data exploitation for			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / <i>Ground Technology</i>	Project (Number/Name) BL7 / <i>Power Projection in A2AD Environments Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
characterizing lines of communication; will design and develop computational framework for rapid determination of road structural capacity. <i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602784A (Military Engineering Technology) / Project T40 (Mobility/Weapons Effects Technology) in FY 2020 as part of the financial restructure in support of Army Modernization Priorities.			
Accomplishments/Planned Programs Subtotals	-	-	2.766

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / <i>Ground Technology</i>	Project (Number/Name) BL9 / <i>Protection from Advanced Weapon Effects Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BL9: <i>Protection from Advanced Weapon Effects Technology</i>	-	0.000	0.000	4.403	-	4.403	3.961	6.166	6.100	5.337	0.000	25.967

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 Army Engineer Research and Development Center.

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

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Materials and Modeling for Force Protection	-	-	1.422
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: Will 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 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602144A / <i>Ground Technology</i>	Project (Number/Name) BL9 / <i>Protection from Advanced Weapon Effects Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602784A (Military Engineering Technology) / Project T40 (Mobility/Weapons Effects Technology) in FY 2020 as part of the financial restructure in support of Army Modernization Priorities.			
Title: Defeat of Complex Attack	-	-	2.981
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: Will 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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602784A (Military Engineering Technology) / Project T40 (Mobility/Weapons Effects Technology) in FY 2020 as part of the financial restructure in support of Army Modernization Priorities.			
Accomplishments/Planned Programs Subtotals	-	-	4.403

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

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

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

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

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is realigned with continuity of effort from the following PEs:

- * 0602105A Materials Technology
- * 0602120A Sensors and Electronic Survivability
- * 0602308A Advanced Concepts and Simulation
- * 0602601A Combat Vehicle and Automotive Technology
- * 0602618A Ballistics Technology
- * 0602622A Chemical, Smoke and Equipment Defeating Technology
- * 0602624A Weapons and Munitions Technology
- * 0602705A Electronics and Electronic Devices
- * 0602709A Night Vision Technology
- * 0602712A Countermines Systems
- * 0602716A Human Factors Engineering Technology
- * 0602783A Computer and Software Technology

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army Date: March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>
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* 0602784A Military Engineering Technology

The following Projects within this PE are new starts:

- * Project BJ9 Autonomous Mobility Tech
- * Project BK2 Virtual Prototyping Technology
- * Project BK3 Next Gen Intelligent Fire Control (NG-IFC) Tech
- * Project BK5 Adv Direct In-Direct Armament Sys (ADIDAS) Tech

A. Mission Description and Budget Item Justification

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

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

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

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

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

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

Change Summary Explanation

FY20 increase related to Science and Technology financial restructuring.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>				Project (Number/Name) BF1 / <i>Autonomous Ground Resupply Tech</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BF1: <i>Autonomous Ground Resupply Tech</i>	-	0.000	0.000	11.301	-	11.301	11.029	0.000	0.000	0.000	0.000	22.330

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

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

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

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p><i>FY 2020 Plans:</i> 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.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology) and PE 0602784 (Military Engineering Technology) / Project T40 (Mob/Wpns Eff Tech) in FY20 as part of the financial restructure.</p>			
<p><i>Title:</i> Autonomous System Modeling and Simulations</p> <p><i>Description:</i> 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.</p> <p><i>FY 2020 Plans:</i> 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.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology) and PE 0602784 (Military Engineering Technology) / Project T40 (Mob/Wpns Eff Tech) in FY20 as part of the financial restructure.</p>	-	-	1.500
Accomplishments/Planned Programs Subtotals	-	-	11.301

<p>C. Other Program Funding Summary (\$ in Millions) N/A</p> <p>Remarks</p>
<p>D. Acquisition Strategy N/A</p>

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

<u>E. Performance Metrics</u> N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>	Project (Number/Name) BF3 / <i>Combat Vehicle Robotics Tech</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BF3: <i>Combat Vehicle Robotics Tech</i>	-	0.000	0.000	11.658	-	11.658	9.191	19.473	21.926	22.236	0.000	84.484

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

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

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>	Project (Number/Name) BF3 / <i>Combat Vehicle Robotics Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
detection/avoidance, mounted/dismounted following, dynamic route planning, manned/unmanned teaming, and individual/ coordinated learning and environmental modeling. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology) in FY20 as part of the financial restructure.				
Title: Autonomous Architecture Description: This effort contributes to the Army's NGCV RAS to implement an open autonomous architecture for an inclusive military library of behaviors that are non-proprietary and in a modular format to allow for design and development of payloads across the enterprise. This effort builds upon architecture activities under the autonomous ground resupply activity, further expanding the Autonomous Ground Vehicle Robotics Architecture for increased complexity of military maneuvers. FY 2020 Plans: Will develop a set of guidelines to enable the robotics community to fulfill the Army's NGCV RAS commonality objectives with an affordable means to deliver advanced capability to the Warfighter by utilizing architectural best practices and standards. Will develop military repositories and an ecosystem for the sharing of robotic vehicle software to help reduce the cost of developing software for autonomous robotic platforms and increase the overall reliability, security, maturity, and interoperability of the software. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology) in FY20 as part of the financial restructure.		-	-	2.150
Title: Human Robotic Interaction Description: This effort contributes to the NGCV RAS to implement a focused approach to deliver optimized unmanned system and manned-unmanned system team performance through reduced cognitive burden for the Soldier while maintaining real-time unmanned system status/activity, overall mission effectiveness, and predictive capability of the system's intended activity. FY 2020 Plans: Will design and develop a multi-vehicle asset control approach that will have the capability to interface with multiple robotic assets on an interface either at a command mission planning level or directly to each asset that will allow for multi-user connection with different levels of authority. Will investigate multi-modal communications interface techniques for soldier interaction that will have		-	-	4.278

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

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

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>				Project (Number/Name) BF6 / <i>Crew Augmentation and Optimization Tech</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BF6: <i>Crew Augmentation and Optimization Tech</i>	-	0.000	0.000	23.027	-	23.027	23.132	23.381	23.891	24.339	0.000	117.770

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Crew Station / Closed Hatch Operations	-	-	4.118

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

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology), PE 0602716A (Human Factors Engineering Technology)/ Project H70 (Human Fact Eng Sys Dev), and PE 0602308A (Advanced Concepts and Simulation)/ Project C90 (Advanced Distributed Simulation) in FY20 as part of the financial restructure.</p>			
<p>Title: Crew Understanding Agents</p> <p>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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology), PE 0602716A (Human Factors Engineering Technology)/ Project H70 (Human Fact Eng Sys Dev), and PE 0602308A (Advanced Concepts and Simulation)/ Project C90 (Advanced Distributed Simulation) in FY20 as part of the financial restructure.</p>	-	-	8.108
<p>Title: Agents Understanding Crew</p>	-	-	6.185

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

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>Description: This effort focuses on increasing intelligent agent ability to understand crew actions, intentions, goals, and general reasoning in order to increase the effectiveness of human-intelligent agent teaming. The effort will enable effective adaptation by intelligent agents, increase appropriateness of intelligent agent actions, increase manned/unmanned team resilience, and is critical for intelligent approaches to dynamic team tasking.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology), PE 0602716A (Human Factors Engineering Technology)/ Project H70 (Human Fact Eng Sys Dev), and PE 0602308A (Advanced Concepts and Simulation)/ Project C90 (Advanced Distributed Simulation) in FY20 as part of the financial restructure.</p>			
<p>Title: Joint Human-Agent Teamwork</p> <p>Description: This effort focuses on providing human intelligent agent teams that have the capability to perform as well as soldier teams, but with additional capabilities including: greater team resilience with robust and adaptive performance, faster dynamic human-agent team reconfiguration to match capabilities to mission requirements, faster and more informed team decision making, and reduced numbers of soldiers as well as risks to them.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology), PE 0602716A (Human Factors Engineering Technology)/ Project H70 (Human Fact Eng Sys Dev), and PE 0602308A (Advanced Concepts and Simulation)/ Project C90 (Advanced Distributed Simulation) in FY20 as part of the financial restructure.</p>	-	-	4.616
Accomplishments/Planned Programs Subtotals	-	-	23.027

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>	Project (Number/Name) BF6 / <i>Crew Augmentation and Optimization Tech</i>
C. Other Program Funding Summary (\$ in Millions) N/A		
Remarks		
D. Acquisition Strategy N/A		
E. Performance Metrics N/A		

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>				Project (Number/Name) BF8 / <i>Artificial Intelligence & Machine Learning Tech</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BF8: <i>Artificial Intelligence & Machine Learning Tech</i>	-	0.000	0.000	18.651	-	18.651	18.938	19.246	31.852	58.094	0.000	146.781

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

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

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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>	Project (Number/Name) BF8 / <i>Artificial Intelligence & Machine Learning Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602705 (Electronics and Electronic Devices) / Project EM8 (High Power and Energy Technology), PE 602120A (Sensors and Electronic Survivability) / Project TS2 (Robotics Technology), and 0602783A (Computer and Software Technology) / Project Y10 (Computer/Info Sci Tech) in FY20 as part of the financial restructure.</p>				
<p>Title: Scalable, Adaptive, and Resilient Autonomous Systems</p> <p>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.</p> <p>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</p>		-	-	7.336

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>foroperations. Will investigate methods, metrics, and tools to facilitate, simulate, and enable testing and evaluation of emerging approaches for individual and collaborative intelligent systems in Army relevant constraints and environments.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602705 (Electronics and Electronic Devices) / Project EM8 (High Power and Energy Technology), PE 602120A (Sensors and Electronic Survivability) / Project TS2 (Robotics Technology), and 0602783A (Computer and Software Technology) / Project Y10 (Computer/Info Sci Tech) in FY20 as part of the financial restructure.</p>				
<p>Title: Context-Based Information Dynamics</p> <p>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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602705 (Electronics and Electronic Devices) / Project EM8 (High Power and Energy Technology), PE 602120A (Sensors and Electronic Survivability) / Project TS2 (Robotics Technology), and 0602783A (Computer and Software Technology) / Project Y10 (Computer/Info Sci Tech) in FY20 as part of the financial restructure.</p>		-	-	2.389
<p>Title: Heterogeneous Computing and Computational Sciences</p> <p>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.</p> <p>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</p>		-	-	1.761

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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>	Project (Number/Name) BF8 / <i>Artificial Intelligence & Machine Learning Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602705 (Electronics and Electronic Devices) / Project EM8 (High Power and Energy Technology), PE 602120A (Sensors and Electronic Survivability) / Project TS2 (Robotics Technology), and 0602783A (Computer and Software Technology) / Project Y10 (Computer/Info Sci Tech) in FY20 as part of the financial restructure.</p>				
<p>Title: Machine Learning with Constrained Resources</p> <p>Description: This effort will research new ML and reinforcement learning methods to address issues of statistically mismatched and incomplete information which must be annotated, collected, classified and used for rapid decisions by joint intelligent agent-Human teams. In addition, multi-modal human interaction approaches will be investigated to ensure effective soldier interactions and understanding of intent. The goal of this research is enable joint human-intelligent agent decision making, optimizing the strengths of each in the decision process and creating an adaptive, agile team. This work applies research conducted in PE 611102/AA6 (Robotics and Mobile Energy) and Project AA9 (Information and Networking).</p> <p>FY 2020 Plans: Will investigate novel on-line ML approaches that enable high-speed (similar to human speed) mobility of autonomous ground vehicles in complex environments on which the vehicle has not been previously trained and by teaming with the soldier to accelerate algorithm training and provide dynamically changing goals for the autonomous ground vehicle.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602705 (Electronics and Electronic Devices) / Project EM8 (High Power and Energy Technology), PE 602120A (Sensors and Electronic Survivability) / Project TS2 (Robotics Technology), and 0602783A (Computer and Software Technology) / Project Y10 (Computer/Info Sci Tech) in FY20 as part of the financial restructure.</p>		-	-	4.134
<p>Title: Ground Robotic Vehicle Mobility & Propulsion Technology</p> <p>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.</p> <p>FY 2020 Plans: Will establish a novel AI/ML algorithm framework to improve vehicle maneuver performance in complex terrains, environments, and damage conditions.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement:</p>		-	-	1.495

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

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>				Project (Number/Name) BF9 / <i>Sensors for Autonomous Operations and Surv Tech</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BF9: <i>Sensors for Autonomous Operations and Surv Tech</i>	-	0.000	0.000	15.283	-	15.283	16.554	19.440	13.250	13.398	0.000	77.925

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

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

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

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

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>	Project (Number/Name) BG2 / <i>Modeling and Simulation for MUMT Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>BG2: Modeling and Simulation for MUMT Technology</i>	-	0.000	0.000	3.966	-	3.966	4.060	7.525	7.767	7.853	0.000	31.171

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

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

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>	Project (Number/Name) BG2 / <i>Modeling and Simulation for MUMT Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
Will develop and improve a simulation environment to investigate autonomous vehicle maneuver; will develop software to automatically detect mobility obstacles in near real-time and mature sensor fusion methods; and will refine mobility algorithms for near real-time predictions. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602784A (Military Engineering Technology) / Project T40 (Mob/Wpns Eff Tech) in FY20 as part of the financial restructure>.				
Accomplishments/Planned Programs Subtotals		-	-	3.966
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				
E. Performance Metrics				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>				Project (Number/Name) BG6 / <i>Advanced Concepts for Active Defense Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BG6: <i>Advanced Concepts for Active Defense Technology</i>	-	0.000	0.000	53.469	-	53.469	55.437	51.645	56.306	56.586	0.000	273.443

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>Title: Computational and Experimental Capability</p> <p>Description: This effort will develop computational design tools and computational and experimental capabilities that support development of advanced protection systems. Such systems include passive, active and hybrid solutions for defeating (multiple) anti-armor threats and exploit solid-dynamic, explosive-driven and magneto-hydrodynamic target interactions. This work allows for predicting armor performance and understanding mechanisms, regardless of vehicle platform, with improved and quantified confidence. This effort leverages the Department of Defense and Department of Energy (DOE) Technical Coordination Group Memorandum of Agreement and directly leverages DOE investments in computational platforms for problems in solid dynamics and impact mechanics.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project C05 (Armor Applied Research) and PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) in FY20 as part of the financial restructure.</p>	-	-	4.868
<p>Title: Multi-Threat Armor Technologies</p> <p>Description: This effort develops multi-threat hybrid armor technologies incorporating both active and passive mechanisms for ground vehicle systems that are effective against future conventional weapons and evolving improvised threats including kinetic and chemical energy as well as blast threats. Most effective designs will be transitioned to PE 0603462A (Next Generation Combat Vehicle Advanced Technology) for further design and maturation.</p> <p>FY 2020 Plans: Will computationally and experimentally explore novel passive, reactive, and active armor protection concepts in support of next generation combat vehicle protection; continue to improve understanding of hybrid armor multi-hit capabilities; continue to evaluate promising multi-threat armor designs utilizing hybrid electromagnetic armor/energetic technologies; explore top attack protection designs and potential mechanisms; develop active lightweight kinetic energy penetrator defeat mechanisms. Validate performance to TRL 4 for most promising designs for transition to PE 0603462A (NGCV Advanced Technology).</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement:</p>	-	-	9.413

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project C05 (Armor Applied Research) and PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) in FY20 as part of the financial restructure.</p> <p>Title: Advanced Armor and Protection Technologies</p> <p>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.</p> <p>FY 2020 Plans: Will develop lightweight armor for protection against Kinetic Energy (KE) and Chemical Energy (CE) threats. Will utilize advanced multi-physics computational tools developed under the computational experimental capability effort to conduct parametric analysis of threat-target interactions. The results of this analysis will aid the design of advanced armor concepts that will undergo physical experimentation (ballistic testing) to validate performance. The most promising concepts will be further developed and transitioned to PE 0603462A (NGCV Advanced Technology) for component development and maturation.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project C05 (Armor Applied Research) and PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) in FY20 as part of the financial restructure.</p>		-	-	5.986
<p>Title: Adaptive and Cooperative Protection</p> <p>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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement:</p>		-	-	9.965

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project C05 (Armor Applied Research) and PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) in FY20 as part of the financial restructure.				
<p>Title: Emerging Overmatch Technologies</p> <p>Description: This effort supports the development and demonstration of lethality and protection concepts that re-establish overmatch for the next generation of manned and unmanned combat platforms. It will tightly couple scientific research within a campaign of learning to form technology concepts for battlefield domination against current and future threats. This research will heavily leverage other efforts within PE 0602145A (NGCV Technology) and PE 0603462A (NGCV Advanced Technology).</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project C05 (Armor Applied Research) and PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) in FY20 as part of the financial restructure.</p>		-	-	2.055
<p>Title: Survivability/Lethality/Vulnerability Analysis Tools and Methodology</p> <p>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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement:</p>		-	-	5.071

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project C05 (Armor Applied Research) and PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) in FY20 as part of the financial restructure.				
<p>Title: Warrior Injury Assessment Manikin (WIAMAN)</p> <p>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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project C05 (Armor Applied Research) and PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) in FY20 as part of the financial restructure.</p>		-	-	1.439
<p>Title: Ground Systems Active Defense Technology Research</p> <p>Description: This effort contributes to the Army's ground vehicle survivability by developing technologies which electronically or physically defeat an incoming threat before it contacts the vehicle. These technologies involve sensors and effectors interacting with an incoming threat to disrupt or destroy in while it is in flight or before it is even fired at a vehicle. This effort designs and develops modern armors that directly complement active defense technologies in order to implement sophisticated mass efficient mechanisms and leverage investments in materials to act as a system for the defeat of advanced threats. This effort designs and develops active blast mitigation technologies to counter the effects of underbody attacks to ground vehicles. This effort will also design and develop the required advanced structures required to accommodate active blast mitigation technologies into vehicles. The design of the structure and active defense technology is critical to an effective blast survivability solution.</p> <p>FY 2020 Plans: Will perform requirements definition and lab scale performance validation of a small flyout countermeasure. Will begin conducting research into component packaging and integration methods and concepts, including complementary base vehicle armor components to capture residual fragments from countermeasure engagements. Packaging and integration subcomponent tests</p>		-	-	14.672

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>	Project (Number/Name) BG6 / <i>Advanced Concepts for Active Defense Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>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.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project C05 (Armor Applied Research) and PE 0602618A (Ballistics Technology) / Project H80 (Survivability and Lethality Technology) in FY20 as part of the financial restructure.</p>				
Accomplishments/Planned Programs Subtotals		-	-	53.469
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				
E. Performance Metrics				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>				Project (Number/Name) BG8 / <i>Obscuration Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BG8: <i>Obscuration Technology</i>	-	0.000	0.000	4.070	-	4.070	2.622	2.677	2.731	2.761	0.000	14.861

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

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

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

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>Description: This effort investigates new materials and compounds to enable safe, effective screening of personnel and equipment across the electromagnetic spectrum.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602622A (Chemical, Smoke and Equipment Defeating Technology) / Project A552 (Smoke/Novel Effect Mun) in FY20 as part of the financial restructure.</p>			
Accomplishments/Planned Programs Subtotals	-	-	4.070

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>				Project (Number/Name) BH2 / <i>C4ISR Modular Autonomy Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BH2: <i>C4ISR Modular Autonomy Technology</i>	-	0.000	0.000	4.874	-	4.874	5.153	2.701	2.755	2.786	0.000	18.269

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

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

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

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

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / Next Generation Combat Vehicle Technology	Project (Number/Name) BH5 / Platform Electrification and Mobility Tech
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BH5: Platform Electrification and Mobility Tech	-	0.000	0.000	10.024	-	10.024	12.810	12.897	7.012	4.080	0.000	46.823

Note

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

A. Mission Description and Budget Item Justification

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

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

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

Work is performed by the United States Army Futures Command.

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

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

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>	Project (Number/Name) BH5 / <i>Platform Electrification and Mobility Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>electrified ground vehicles have enough power for mobility, silent watch, and enables energy based capabilities including electromagnetic armor and directed energy weapons.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology) in FY20 as part of the financial restructure.</p>				
<p>Title: Novel Propulsion Research</p> <p>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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology) in FY20 as part of the financial restructure.</p>		-	-	1.628
<p>Title: Platform Electrification and Mobility Research</p> <p>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,</p>		-	-	7.482

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

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
and energy storage. Electrification of these platforms will enable advanced lethality and protection systems, reduced battlefield fuel consumption, and provide new capabilities such as burst acceleration, extended silent mobility and silent watch.			
<i>FY 2020 Plans:</i> 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 develop high voltage/high temperature generator, power electronics, electric motor drives, and energy storage system.			
<i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	10.024

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / Next Generation Combat Vehicle Technology	Project (Number/Name) BH7 / Enhanced VETRONICS Technology
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BH7: Enhanced VETRONICS Technology	-	0.000	0.000	3.603	-	3.603	3.675	3.751	6.155	6.223	0.000	23.407

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

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

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

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>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.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from of PE 0602705A (Electronics and Electronic Devices) / Project EM8 (High Power and Energy Component Technology) and PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology) in FY20 as part of the financial restructure.</p>			
Accomplishments/Planned Programs Subtotals	-	-	3.603

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>				Project (Number/Name) BH9 / <i>Protection for Autonomous Systems Tech</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BH9: <i>Protection for Autonomous Systems Tech</i>	-	0.000	0.000	2.548	-	2.548	2.000	3.500	3.570	3.609	0.000	15.227

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

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

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

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

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>				Project (Number/Name) B12 / <i>Sensor Protection Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
B12: <i>Sensor Protection Technology</i>	-	0.000	0.000	10.584	-	10.584	11.499	11.786	12.033	12.178	0.000	58.080

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Sensor Protection Technology	FY 2018	FY 2019	FY 2020
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,	-	-	6.688

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>	Project (Number/Name) BI2 / <i>Sensor Protection Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>and emerging signature reduction schemas. This effort is coordinated with PE 0603462A (NGCV Advanced Technology), 0603118A (Soldier Lethality Advanced Technology), 0603465A (Future Vertical Lift Advanced Technology), and 0602143A (Soldier Lethality Technology).</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602120A (Sensors and Electronic Survivability) / Project H16 (S3I Technology), PE 0602705A (Electronics and Electronic Devices) / Project H94 (Elec and Electronic Dev), and PE 0602712A (Countermeasure Systems) / Project H35 (Camouflage & Counter-Recon Tech), in FY20 as part of the financial restructure.</p>				
<p>Title: Laser Protection Technologies</p> <p>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.</p> <p>FY 2020 Plans: Will investigate tunable mid-wave infrared filter designs and improve tunable long-wave infrared filters based on previous experiments; will improve multi-chromophore solid-state optical limiter to increase operational bandwidth; will investigate pulsed wave laser limiter concepts in the mid-wave infrared; and will improve high-power continuous wave laser protection concepts.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: PE 0602145A (NGCV Technology) / Project BI2 (Sensor Protection Technology) was previously PE 0602712A (Countermeasure Systems) / Project H35 (Camouflage & Counter-Recon Technology), a portion of PE 0602705A (Electronics and Electronic Devices) / Project H94 (Electronics and Electronic Devices), and a portion of PE 0602120A (Sensors and Electronic Survivability) / Project H16 (S3I Technology) in FY19. Funding has been realigned in FY20 to reflect the financial restructure.</p>		-	-	3.896
Accomplishments/Planned Programs Subtotals		-	-	10.584

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>	Project (Number/Name) B12 / <i>Sensor Protection Technology</i>

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>				Project (Number/Name) BL4 / <i>Materials Application and Integration Tech</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BL4: <i>Materials Application and Integration Tech</i>	-	0.000	0.000	8.313	-	8.313	9.561	9.730	9.921	10.023	0.000	47.548

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

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

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019	
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>	Project (Number/Name) B14 / <i>Materials Application and Integration Tech</i>	
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019
<p>Title: Lightweight Armor Materials and Processes for Vehicle Protection</p> <p>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).</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602105A (Materials Technology) / Project H84 (Materials) in FY20 as part of the financial restructure.</p>		-	-
<p>Title: Novel Armor Materials and Processes for Vehicle Protection</p> <p>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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602105A (Materials Technology) / Project H84 (Materials) in FY20 as part of the financial restructure.</p>		-	-
<p>Title: Advanced Vehicle Power Technology Alliance Materials</p> <p>Description: This effort develops and matures lightweight materials and joining technologies in support of lighter military vehicles which are more fuel-efficient and expeditionary with superior mobility and protection of both vehicles and occupants. Lighter materials/constructions and advances in joining technologies such as multi-material and dissimilar material joining will lead to lightweight military vehicle structures.</p>		-	-
		3.907	2.513
		1.893	

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>	Project (Number/Name) B14 / <i>Materials Application and Integration Tech</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p><i>FY 2020 Plans:</i> 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.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602105A (Materials Technology) / Project H84 (Materials) in FY20 as part of the financial restructure.</p>			
Accomplishments/Planned Programs Subtotals	-	-	8.313

<p>C. Other Program Funding Summary (\$ in Millions) N/A</p> <p>Remarks</p> <p>D. Acquisition Strategy N/A</p> <p>E. Performance Metrics N/A</p>
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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>	Project (Number/Name) B19 / <i>Vehicle System Security Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>B19: Vehicle System Security Technology</i>	-	0.000	0.000	2.951	-	2.951	2.530	2.426	2.285	2.127	0.000	12.319

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

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

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>	Project (Number/Name) BI9 / <i>Vehicle System Security Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: PE 0602145A (NGCV Technology) / Project BI9 (Vehicle System Security Technology) was previously PE 0602601 (Combat Vehicle and Automotive Technology) / Project H77 (National Automotive Center) in FY19. Funding has been realigned in FY20 to reflect the financial restructure.</p>				
Accomplishments/Planned Programs Subtotals		-	-	2.951
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				
E. Performance Metrics				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>	Project (Number/Name) BJ2 / <i>Tactical and Navigation Lasers Sensors Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>BJ2: Tactical and Navigation Lasers Sensors Technology</i>	-	0.000	0.000	4.990	-	4.990	5.458	5.567	5.678	5.742	0.000	27.435

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

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

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>	Project (Number/Name) BJ2 / <i>Tactical and Navigation Lasers Sensors Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
Will develop mid-wave infrared component technology and conduct field trial to evaluate range performance and optical detection capabilities. Will investigate laser detection and ranging applications to support autonomous vehicle operations. <i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602709A (Night Vision Technology)/ Project H95 (Night Vision and Electro Optic Technology) in FY20 as part of the financial restructure.				
Accomplishments/Planned Programs Subtotals		-	-	4.990
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>				Project (Number/Name) BJ3 / <i>Hydrogen Based Combat System Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BJ3: <i>Hydrogen Based Combat System Technology</i>	-	0.000	0.000	7.127	-	7.127	6.180	4.599	3.655	2.899	0.000	24.460

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

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

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

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

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>				Project (Number/Name) BJ7 / <i>Detection of Explosive Hazards Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>BJ7: Detection of Explosive Hazards Technology</i>	-	0.000	0.000	11.882	-	11.882	12.115	12.326	10.717	10.837	0.000	57.877

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Detection of Explosive Hazards Technology	FY 2018	FY 2019	FY 2020
Description: This effort focuses on designing and developing novel component technology for detection and defeat of mines, minefields, IEDs and other explosive hazard threats for manned and unmanned vehicles. Artificial Intelligence and machine learning tools will be exploited to provide autonomous capabilities and enable increased survivability through greatly increased mine detection standoff ranges. This effort is coordinated with PEs 0633462A (NGCV Advanced Technology), 0603118A (Soldier Lethality Advanced Technology), and 0602143A (Soldier Lethality Technology).	-	-	11.882
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			

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

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

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>	Project (Number/Name) BJ9 / <i>Autonomous Mobility Tech</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>BJ9: Autonomous Mobility Tech</i>	-	0.000	0.000	3.060	-	3.060	2.500	4.000	0.000	0.000	0.000	9.560

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Big Data Storage Techniques	-	-	2.960
Description: This effort develops techniques and technologies for storage of machine learning data sets to be used collaboratively for Army research.			
FY 2020 Plans:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>	Project (Number/Name) BJ9 / <i>Autonomous Mobility Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort is a new start in FY20.</p>				
<p>Title: Unmanned Aerial Vehicle Mapping</p> <p>Description: Develop a collaboration of UAV map input for ground vehicle mobility via artificial intelligence and machine learning.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort is a new start in FY20.</p>		-	-	0.100
Accomplishments/Planned Programs Subtotals		-	-	3.060
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				
E. Performance Metrics				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / <i>Next Generation Combat Vehicle Technology</i>	Project (Number/Name) BK2 / <i>Virtual Prototyping Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BK2: <i>Virtual Prototyping Technology</i>	-	0.000	0.000	5.426	-	5.426	5.426	5.300	5.426	5.155	0.000	26.733

Note

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

A. Mission Description and Budget Item Justification

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

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

Work in this Project supports the Army Modernization Priority NGCV.

This work is conducted by United States Army Futures Command.

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

B. Accomplishments/Planned Programs (\$ in Millions)

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

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

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
into warfighter behaviors and tactics, and informs requirements for the Army?s next generation of ground combat vehicles and technologies.			
<i>FY 2020 Plans:</i> Will 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.			
<i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort is a new start in FY20.			
Accomplishments/Planned Programs Subtotals	-	-	5.426

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602145A / Next Generation Combat Vehicle Technology				Project (Number/Name) BK3 / Next Gen Intelligent Fire Control (NG-IFC) Tech			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BK3: Next Gen Intelligent Fire Control (NG-IFC) Tech	-	0.000	0.000	1.050	-	1.050	3.450	2.850	1.770	0.892	0.000	10.012

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

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

C. Other Program Funding Summary (\$ in Millions)

N/A

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

C. Other Program Funding Summary (\$ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602145A / Next Generation Combat Vehicle Technology	Project (Number/Name) BK5 / Adv Direct In-Direct Armament Sys (ADIDAS) Tech
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BK5: Adv Direct In-Direct Armament Sys (ADIDAS) Tech	-	0.000	0.000	1.190	-	1.190	0.913	0.939	0.580	0.378	0.000	4.000

Note

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

A. Mission Description and Budget Item Justification

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

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

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

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

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

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Advanced Direct In-Direct Armament System Technology	FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2020 Plans: Will investigate armament system configurations for high elevations and advanced recoil mitigation to reduce impulse. Will develop component technologies for ammunition handling and the primary weapon that support the configurations needed for high elevation and reduced impulse.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement:</p>	-	-	1.190

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

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

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army											Date: March 2019	
Appropriation/Budget Activity 2040: Research, Development, Test & Evaluation, Army / BA 2: Applied Research					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology							
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	0.000	0.000	114.516	-	114.516	133.431	117.508	111.923	114.124	0.000	591.502
AM6: Modular RF Communications Technology	-	0.000	0.000	3.909	-	3.909	8.313	6.091	5.193	8.321	0.000	31.827
AM8: Protected SATCOM Technology	-	0.000	0.000	9.600	-	9.600	5.000	0.000	0.000	0.000	0.000	14.600
AN3: Non Traditional Waveforms Technology	-	0.000	0.000	3.291	-	3.291	2.269	7.110	7.252	4.263	0.000	24.185
AN5: Protected SATCOM-WB Global SATCOM Inter Canc Tech	-	0.000	0.000	0.400	-	0.400	0.000	0.000	0.000	0.000	0.000	0.400
AN7: COE - Every Receiver is a Sensor Technology	-	0.000	0.000	3.005	-	3.005	3.065	3.126	3.189	3.225	0.000	15.610
AN9: UNT - Every Receiver is a Sensor Technology	-	0.000	0.000	3.850	-	3.850	4.000	3.040	2.081	2.105	0.000	15.076
AO2: Stand-In Advanced RF Effects (STARE)	-	0.000	0.000	7.504	-	7.504	6.387	2.053	2.113	2.136	0.000	20.193
AO4: Energy Efficient Devices Technology	-	0.000	0.000	5.412	-	5.412	5.478	5.843	5.415	5.475	0.000	27.623
AO5: Tag Track and Locate Small Satellites Technology	-	0.000	0.000	4.406	-	4.406	3.837	3.767	3.888	3.930	0.000	19.828
AP4: CEMA Camouflage Technology	-	0.000	0.000	9.716	-	9.716	9.851	10.125	9.976	9.818	0.000	49.486
AP5: Electronic Warfare Technology	-	0.000	0.000	2.823	-	2.823	2.918	3.015	3.087	3.128	0.000	14.971
AP7: Comms/Horiz Int for Army Mod Priorities Tech	-	0.000	0.000	0.500	-	0.500	3.035	0.000	0.000	0.000	0.000	3.535
AQ2: EW Techniques Technology*	-	0.000	0.000	0.000	-	0.000	0.500	0.500	0.520	0.525	0.000	2.045
AQ6: Command Applications of Machine Learning Technology*	-	0.000	0.000	0.000	-	0.000	1.642	3.682	3.854	3.897	0.000	13.075

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army											Date: March 2019		
Appropriation/Budget Activity					R-1 Program Element (Number/Name)								
2040: Research, Development, Test & Evaluation, Army / BA 2: Applied Research					PE 0602146A / Network C3I Technology								
AQ7: High Tempo Data Driven Decision Tools Technology*	-	0.000	0.000	0.000	-	0.000	1.407	1.979	0.000	0.000	0.000	3.386	
AQ9: Expeditionary Data to Decisions Technology	-	0.000	0.000	2.000	-	2.000	2.783	2.896	2.856	2.888	0.000	13.423	
AR1: Robust, Resilient and Intelligent C3I Technology	-	0.000	0.000	8.700	-	8.700	13.788	14.048	14.329	14.489	0.000	65.354	
AR3: Intelligent Environmental Battlefield Awareness*	-	0.000	0.000	0.000	-	0.000	3.890	3.622	3.073	2.135	0.000	12.720	
AR5: Understanding the Environment as a Threat Technolo	-	0.000	0.000	3.943	-	3.943	2.333	1.982	1.285	0.981	0.000	10.524	
AR7: Sensing in Contested Environments Technology*	-	0.000	0.000	0.000	-	0.000	1.202	1.208	0.986	0.997	0.000	4.393	
AR9: Persistent Geophysical Sensing-Infrasound Tech	-	0.000	0.000	3.963	-	3.963	4.343	3.459	2.500	2.279	0.000	16.544	
AT2: Subterranean Detection and Monitoring Technology	-	0.000	0.000	1.600	-	1.600	3.650	1.278	1.050	1.437	0.000	9.015	
AT4: GeoINT - OPS Merge Technology*	-	0.000	0.000	0.000	-	0.000	0.000	0.000	0.000	6.096	0.000	6.096	
AT7: Network-Enabled GeoSpatial-GEOINT Services Tech	-	0.000	0.000	2.992	-	2.992	3.011	2.446	2.000	0.000	0.000	10.449	
AT9: Tactical GeoSpatial Information Capabilities Techn	-	0.000	0.000	2.771	-	2.771	4.244	1.800	1.780	0.000	0.000	10.595	
AU3: Geospatially Enabled Operational Design Technology	-	0.000	0.000	3.173	-	3.173	3.468	2.803	1.200	0.000	0.000	10.644	
AU5: Automated Analytics for Operational Environment	-	0.000	0.000	3.950	-	3.950	3.242	3.261	1.034	0.000	0.000	11.487	
AU7: GEOInt/Ops Integration for Multi-echelon Orders*	-	0.000	0.000	0.000	-	0.000	0.000	0.000	4.012	4.058	0.000	8.070	

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity	R-1 Program Element (Number/Name)											
2040: Research, Development, Test & Evaluation, Army / BA 2: Applied Research	PE 0602146A / Network C3I Technology											
AU9: GEOInt/Ops Logistics Integration-Planning Tech*	-	0.000	0.000	0.000	-	0.000	0.000	0.000	0.000	2.280	0.000	2.280
AV3: Foundational S&T for Network C3I Technology*	-	0.000	0.000	0.000	-	0.000	1.929	1.970	2.103	2.210	0.000	8.212
AV5: Protective Technologies	-	0.000	0.000	6.800	-	6.800	7.700	7.846	6.449	6.521	0.000	35.316
AV6: Airborne Engineering Support Technology	-	0.000	0.000	0.882	-	0.882	0.900	0.918	0.936	0.947	0.000	4.583
AV7: Atmospheric Modeling and Meterological Technology	-	0.000	0.000	5.812	-	5.812	5.950	6.070	6.192	6.261	0.000	30.285
AV9: Advanced PNT for GPS Independent Environments Tech	-	0.000	0.000	6.974	-	6.974	6.662	6.838	8.743	8.841	0.000	38.058
AW1: Autonomous Navigation Technology	-	0.000	0.000	0.400	-	0.400	0.300	0.300	0.300	0.000	0.000	1.300
AW3: DoD PNT M&S Collaborative Initiative (CI) Technolo	-	0.000	0.000	2.000	-	2.000	2.000	0.000	0.000	0.000	0.000	4.000
AW5: Modular GPS Independent Sensors Technology	-	0.000	0.000	4.140	-	4.140	4.334	4.432	4.527	4.881	0.000	22.314

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

Note

In Fiscal Year (FY) 2020 this Program Element (PE) 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

A. Mission Description and Budget Item Justification

This Program Element (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

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>
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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 at; and the collection, processing, and dissemination of information for intelligence, surveillance, and reconnaissance.

Commercial technologies are continuously investigated and leveraged where possible.

Project AM6 develops techniques, methods, and standards for automation and intelligence to optimally route data among available radio frequency and networking technologies. Project AM8 investigates resiliency of Wideband Satellite Communications (SATCOM) in contested and congested electromagnetic environments. Project AN1 designs and develops technologies to enable gateway communications across disparate Narrowband SATCOM networks. Project AN3 develops non-traditional protocols and technologies to provide spectrum efficiency, high bandwidth, lower spectrum footprint, or anti-jam capabilities to tactical networks. Project AN5 develops interference cancellation technologies to allow uninterrupted and resilient communications over the Wideband Global Satellite constellation. Project AN7 and AN9 develop the algorithms to enable every communication receiver in the tactical environment to operate as a sensor while maintaining the systems' original networking capability. Project AO2 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. Project AO4 investigates energy efficiency improvements in support of four key areas: Radio Frequency (RF) component devices, optoelectronic devices for alternative communications modes, long-lived and high efficiency power sources, and efficient wireless power and data transfer technologies. Project AO5 researches and develops space-based remote sensing, signal, and information processing software in collaboration with other Department of Defense (DoD) and other government agencies to support space force enhancement and space superiority advanced technology integration into Army battlefield operating systems. Project AO8 develops defensive cyber technology to ensure that data traversing the network remains verified and has not been modified through unauthorized means. Project AP1 designs technologies to counter enemy cyber threats by delaying, disrupting, and deterring their ability to successfully attack tactical systems, applications, and critical data. Project AP3 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 and hardware, algorithms, and methods that jointly adapt to support uninterrupted communications. Project AP4 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. Project AP5 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 electronic attack (EA), EW support (ES), and electronic protection (EP). Project AP7 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. Project AQ3 investigates the application of machine learning technologies to assist in capability development and mission execution processes with respect to Offensive Cyber Operations (OCO)/RF Enabled capabilities. Project AQ9 investigates, codes and designs software, and algorithms that improve Mission Command by increasing situational understanding, via the intelligent sharing of data (application of artificial intelligence) in degraded networks during high op-tempo missions or while under cyber-attack. Project AR1 develops and characterizes machine learning and artificial intelligence methods for processing, analysis and provisioning control of smart, distributed, networked sensors and devices. Project AR5 designs and advances mission planning software enabling the Solider to identify, track, and plan for industrial or commercial chemical/environmental threats. Project AR9 develops algorithms, software, and kitted hardware solutions to enable near-real-time battlespace awareness to persistently monitor and update courses of action regarding critical infrastructure conditions. Project AT2 develops an integrated suite of subterranean threat detection and vulnerability assessment/decision technologies that enhance survivability and threat

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>
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awareness for the soldier operating in environments with subterranean domains. Project AT7 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. Project AT9 investigates and develops next generation geospatial analytical tools for 3D complex environments for low echelon and tactical edge exploitation. Project AU3 investigates, advances and develops a geospatially enabled collaborative planning environment, accessible across echelons, by providing the ability to perform conceptual planning and problem framing. Project AU5 investigates and develops technologies that capture hidden threat patterns and operational environment changes from textual reporting.

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 Lethality Advanced Technology), PE 0603462A (Next Generation Combat Vehicle Advanced Technology), PE 0603464A (Long Range Precision Fires 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.

B. Program Change Summary (\$ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	0.000	0.000	0.000	-	0.000
Current President's Budget	0.000	0.000	114.516	-	114.516
Total Adjustments	0.000	0.000	114.516	-	114.516
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	114.516	-	114.516

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity
2040: *Research, Development, Test & Evaluation, Army / BA 2: Applied Research*

R-1 Program Element (Number/Name)
PE 0602146A / *Network C3I Technology*

Change Summary Explanation

FY20 increase related to Science and Technology financial restructuring.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AM6 / Modular RF Communications Technology
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AM6: <i>Modular RF Communications Technology</i>	-	0.000	0.000	3.909	-	3.909	8.313	6.091	5.193	8.321	0.000	31.827

Note

In Fiscal Year (FY) 2020 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 route 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 9Network 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 2018	FY 2019	FY 2020
Title: Modular Radio Frequency Communications Technology	-	-	3.909
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: Will 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 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AM6 / <i>Modular RF Communications Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602782A (Command, Control, Communications Technology) / Project H92 (Communications Technology) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	3.909

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>				Project (Number/Name) AM8 / <i>Protected SATCOM Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AM8: <i>Protected SATCOM Technology</i>	-	0.000	0.000	9.600	-	9.600	5.000	0.000	0.000	0.000	0.000	14.600

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 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)

Title: Protected Satellite Communication Technology	FY 2018	FY 2019	FY 2020
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.	-	-	9.600
FY 2020 Plans: Will fund 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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AM8 / <i>Protected SATCOM Technology</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
commercial Low Earth Orbit (LEO) satellite mega-constellations to select applicable technologies to utilize and build upon for use in a mounted/dismounted environment.			
<i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602782A (Command, Control, Communications Technology) / Project H92 9Communications Technology) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	9.600

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AN3 / Non Traditional Waveforms Technology
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AN3: <i>Non Traditional Waveforms Technology</i>	-	0.000	0.000	3.291	-	3.291	2.269	7.110	7.252	4.263	0.000	24.185

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 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)

Title: Non Traditional Waveforms Technology	FY 2018	FY 2019	FY 2020
Description: This effort investigates non-traditional protocols and technologies to provide spectrum efficiency, high bandwidth, lower spectrum footprint, or anti-jam capabilities to tactical networks. This effort develops network resiliency for the dismounted and vehicular units through science & technology investigation.	-	-	3.291
FY 2020 Plans: Will 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 design adaptive power control techniques and dismounted networking for improved low probability of intercept / low probability of detection (LPI/LPD) characteristics.			
FY 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AN3 / <i>Non Traditional Waveforms Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602782A (0602782A Command, Control, Communications Technology) / Project H92 (Communications Technology) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	3.291

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AN5 / Protected SATCOM-WB Global SATCOM Inter Canc Tech			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AN5: Protected SATCOM-WB Global SATCOM Inter Canc Tech	-	0.000	0.000	0.400	-	0.400	0.000	0.000	0.000	0.000	0.000	0.400

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 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 2018	FY 2019	FY 2020
Title: Protected Satellite Communication ? Wide Band Global Satellite Communication Interference Cancellation Technology	-	-	0.400
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: Will validate the performance of interference cancelling technology to protect satellite communications; will 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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602782A (Command, Control, Communications Technology / Project H92 (Communications Technology) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	0.400

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AN5 / Protected SATCOM-WB Global SATCOM Inter Canc Tech

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AN7 / COE - Every Receiver is a Sensor Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AN7: COE - Every Receiver is a Sensor Technology	-	0.000	0.000	3.005	-	3.005	3.065	3.126	3.189	3.225	0.000	15.610

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.

Work in this Project complements PE 06022146A Network C3I Advanced Technology \ Project AN9 UNT - 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 U.S. Army Futures Command.

Fiscal Year (FY) 2020 realignments are due to financial restructuring in support of Army Modernization Priorities.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Data Analytics for Situational Awareness	-	-	3.005
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. Work being accomplished under PE 06033463/Project AO1 complements this effort.			
FY 2020 Plans: Will investigate deep learning techniques to leverage tactical and national data sources identified in FY 2019 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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AN7 / <i>COE - Every Receiver is a Sensor Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
of Battle (EEOB). 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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602270A (Electronic Warfare Technology) / Project 906 (Tactical Electronic Warfare Applied Research) in FY20 as part of the financial restructure.				
Accomplishments/Planned Programs Subtotals		-	-	3.005
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AN9 / UNT - Every Receiver is a Sensor Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AN9: UNT - Every Receiver is a Sensor Technology	-	0.000	0.000	3.850	-	3.850	4.000	3.040	2.081	2.105	0.000	15.076

Note
 In Fiscal Year (FY) 2020 this Project is 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 06033463A (Network C3I Advanced Technology) \ Project AO1 (UNT - Every Receiver is a Sensor Advanced Tech) .

Work in this Project complements PE 06022146A Network C3I Advanced 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 2018	FY 2019	FY 2020
Title: Unified Network Technology (UNT) - Every Receiver is a Sensor Technology	-	-	1.850
Description: This effort 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 effort matures standards and protocols to expand the CEMA situational understanding.			
FY 2020 Plans: Will 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; design and implement method and/or interface to transmit RF sensed metadata for use in intelligence.			
FY 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AN9 / <i>UNT - Every Receiver is a Sensor Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602782A (Command, Control, Communications Technology) / Project H92 (Communications Technology) in FY20 as part of the financial restructure.				
Title: Multi Intelligence Modernization Components and Architecture		-	-	2.000
Description: This effort will investigate 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 RF energy to command our use of the electromagnetic spectrum while denying its use to our adversaries.				
FY 2020 Plans: Will 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. 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. Work being accomplished under PE 06033463 Network C3I Advanced Technology/Project AN8 COE - Every Receiver is a Sensor Advanced Tech complements this effort.				
FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602782A (Command, Control, Communications Technology) / Project H92 (Communications Technology) in FY20 as part of the financial restructure.				
Accomplishments/Planned Programs Subtotals		-	-	3.850
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AO2 / Stand-In Advanced RF Effects (STARE)			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AO2: Stand-In Advanced RF Effects (STARE)	-	0.000	0.000	7.504	-	7.504	6.387	2.053	2.113	2.136	0.000	20.193

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)

Title: RF Electronic Attack/Surveillance	FY 2018	FY 2019	FY 2020
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.	-	-	2.000
FY 2020 Plans: Will 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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AO2 / Stand-In Advanced RF Effects (STARE)		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
and conduct laboratory experiments to determine effectiveness; and investigate techniques for identification and geolocation of advanced communications transceivers. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602705A (Electronics and Electronic Devices) / Project EM8 (High Power And Energy Component Technology), PE 0602782A (Command, Control, Communications technology) / Project H92 (Communications Technology) and PE 0602270A (Electronic Warfare Technology) / Project 906 (Tactical Electronic Warfare Applied Research) in FY20 as part of the financial restructure.				
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: Will 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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602705A (Electronics and Electronic Devices) / Project EM8 (High Power And Energy Component Technology), PE 0602782A (Command, Control, Communications technology) / Project H92 (Communications Technology) and PE 0602270A (Electronic Warfare Technology) / Project 906 (Tactical Electronic Warfare Applied Research) in FY20 as part of the financial restructure.		-	-	2.996
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: Will 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. 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 2019 to FY 2020 Increase/Decrease Statement:		-	-	2.508

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AO2 / <i>Stand-In Advanced RF Effects (STARE)</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602705A (Electronics and Electronic Devices) / Project EM8 (High Power And Energy Component Technology), PE 0602782A (Command, Control, Communications technology) / Project H92 (Communications Technology) and PE 0602270A (Electronic Warfare Technology) / Project 906 (Tactical Electronic Warfare Applied Research) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	7.504

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AO4 / Energy Efficient Devices Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AO4: <i>Energy Efficient Devices Technology</i>	-	0.000	0.000	5.412	-	5.412	5.478	5.843	5.415	5.475	0.000	27.623

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 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 2018	FY 2019	FY 2020
Title: Energy Efficient Electronic and Photonic Components	-	-	5.412
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: Will 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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AO4 / <i>Energy Efficient Devices Technology</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
power and data technologies with >10% efficiency enabling squad-level power and data transfer; and explore methods to support higher rate and energy density wireless battery recharging.			
<i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602705A (Electronics and Electronic Devices) / Project H94 (Elect & Electronic Dev) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	5.412

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AO5 / Tag Track and Locate Small Satellites Technology
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AO5: <i>Tag Track and Locate Small Satellites Technology</i>	-	0.000	0.000	4.406	-	4.406	3.837	3.767	3.888	3.930	0.000	19.828

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
 Program Element (PE) 0602120A Sensors and Electronic Survivability:
 * Project TS1 Tactical Space Research

A. Mission Description and Budget Item Justification

This Project researches, develops, 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 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/Army Forces Strategic Command in Huntsville, AL.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Tag Track and Locate Small Satellites	-	-	3.256
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: Will fund research and validate software, hardware, and algorithms used to enable space-based capabilities in support of the Army's Modernization Priorities. Will also investigate the maturity and feasibility of commercial advances and opportunities in small satellite constellation and payload management for apply to future Army concepts.			
FY 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AO5 / <i>Tag Track and Locate Small Satellites Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602120A (Sensors and Electronic Survivability) / Project TS1 (Tactical Space Research) in FY20 as part of the financial restructure.				
<p>Title: Space Components and Systems Assessment Technology</p> <p>Description: This effort will fund research to conduct experiments and validate hardware and software components and models to further anchor laboratory capabilities enabling small spacecraft and payload design and development.</p> <p>FY 2020 Plans: Will fund research and validate software, hardware, and algorithms used to enable space-based capabilities in support of the Army's Modernization Priorities. Will also investigate the maturity and feasibility of commercial advances and opportunities in small satellite constellation and payload management for application to future Army concepts. Will conduct experiments and validate hardware and software components and models to further anchor laboratory capabilities enabling small spacecraft and payload design and development.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602120A (Sensors and Electronic Survivability) / Project TS1 (Tactical Space Research) in FY20 as part of the financial restructure.</p>		-	-	1.150
Accomplishments/Planned Programs Subtotals		-	-	4.406
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				
E. Performance Metrics				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AP4 / CEMA Camouflage Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AP4: CEMA Camouflage Technology	-	0.000	0.000	9.716	-	9.716	9.851	10.125	9.976	9.818	0.000	49.486

Note

In Fiscal Year (FY) 2020 this Project is 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.

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 2018	FY 2019	FY 2020
<p>Title: RF/Cyber Sensing and Deception</p> <p>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.</p> <p>FY 2020 Plans: Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602705A (Electronics and Electronic Devices) / Project EM8 (High Power and Energy Component Technology) in FY20 as part of the financial restructure.</p>	-	-	0.492
<p>Title: Dynamic Intelligent Networks and Cyber Camouflage and Decoy for CEMA</p>	-	-	3.419

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AP4 / <i>CEMA Camouflage Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2020 Plans: Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602705A (Electronics and Electronic Devices) / Project EM8 (High Power and Energy Component Technology) in FY20 as part of the financial restructure.</p>				
<p>Title: Understanding, Protecting, and Enabling CEMA Effects</p> <p>Description: This research develops methodology and approaches to estimate and predict CEMA effects utilizing studies of the interaction of cyber and electromagnetic threats on future networks, and network-enabled systems, in a complex multi-domain operations. Abstracting, generalizing, and automating multi-domain CEMA operations including development of analysis and assessment capabilities to anticipate future threat. Live, virtual, and simulated environments will be developed to assess future networks, and network-enabled systems, to estimate the effect of CEMA technologies and discover critical vulnerabilities.</p> <p>FY 2020 Plans: Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602705A (Electronics and Electronic Devices) / Project EM8 (High Power and Energy Component Technology) in FY20 as part of the financial restructure.</p>		-	-	3.190
<p>Title: Vulnerability Analysis Methodology for CEMA Threats</p> <p>Description: This research includes studies on threat/target interactions to develop experimental and analytical methodology for separate and combined cyber and electromagnetic threat attack to assess vulnerabilities in a multi-domain complex environment. This research will help better support and inform Army technology and system designers, analysts, evaluators, and decision</p>		-	-	2.615

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AP4 / <i>CEMA Camouflage Technology</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>makers. Experimental and analysis methodology will be developed to investigate vulnerabilities of complex future networks with multiple communications modalities, advanced camouflage and decoy techniques in the cyber and electromagnetic areas, and advance Positioning, Navigation, and Timing (PNT) systems.</p> <p><i>FY 2020 Plans:</i> Will 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).</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602705A (Electronics and Electronic Devices) / Project EM8 (High Power and Energy Component Technology) in FY20 as part of the financial restructure.</p>			
Accomplishments/Planned Programs Subtotals	-	-	9.716

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AP5 / Electronic Warfare Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AP5: <i>Electronic Warfare Technology</i>	-	0.000	0.000	2.823	-	2.823	2.918	3.015	3.087	3.128	0.000	14.971

Note

In Fiscal Year (FY) 2020 this Project is 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 2018	FY 2019	FY 2020
Title: Electronic Warfare Technology Research	-	-	2.180
Description: This effort 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).			
FY 2020 Plans: Will 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; will 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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AP5 / <i>Electronic Warfare Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602120A (Sensors and Electronic Survivability) / Project H16 (S3I Technology) and PE 0602705A (Electronics and Electronic Devices) / Project EM8 (High Power and Energy Component Technology) in FY20 as part of the financial restructure.				
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: Will 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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602120A (Sensors and Electronic Survivability) / Project H16 (S3I Technology) and PE 0602705A (Electronics and Electronic Devices) / Project EM8 (High Power and Energy Component Technology) in FY20 as part of the financial restructure.		-	-	0.643
Accomplishments/Planned Programs Subtotals		-	-	2.823
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AP7 / Comms/Horiz Int for Army Mod Priorities Tech			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>AP7: Comms/Horiz Int for Army Mod Priorities Tech</i>	-	0.000	0.000	0.500	-	0.500	3.035	0.000	0.000	0.000	0.000	3.535

Note
 In Fiscal Year (FY) 2020 this Project is 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 2018	FY 2019	FY 2020
Title: Communications Support to Army Modernization Priorities / Horizontal Integration Fields Technology	-	-	0.500
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: Will 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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602782A (Command, Control, Communications Technology) / Project H92 (Communications Technology) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	0.500

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AP7 / <i>Comms/Horiz Int for Army Mod Priorities Tech</i>
C. Other Program Funding Summary (\$ in Millions) N/A		
Remarks		
D. Acquisition Strategy N/A		
E. Performance Metrics N/A		

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AQ9 / Expeditionary Data to Decisions Technology
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AQ9: Expeditionary Data to Decisions Technology	-	0.000	0.000	2.000	-	2.000	2.783	2.896	2.856	2.888	0.000	13.423

Note

In Fiscal Year (FY) 2020 this Project is 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)

Title: Expeditionary Data to Decisions Technology	FY 2018	FY 2019	FY 2020
Description: This effort researches 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 researches 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.	-	-	2.000
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 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AQ9 / <i>Expeditionary Data to Decisions Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602782A Command, Control and Communications Technology) / Project 779 (Command, Control and Platform Electronics Tech) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	2.000

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AR1 / Robust, Resilient and Intelligent C3I Technology
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AR1: <i>Robust, Resilient and Intelligent C3I Technology</i>	-	0.000	0.000	8.700	-	8.700	13.788	14.048	14.329	14.489	0.000	65.354

Note

In Fiscal Year (FY) 2020 this Project is 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)

Title: Intelligent Signal and Image Analytics for C3I	FY 2018	FY 2019	FY 2020
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.	-	-	6.344
FY 2020 Plans: Will 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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AR1 / <i>Robust, Resilient and Intelligent C3I Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602120A (Sensors and Electronic Survivability) / Project H16 (S3I Technology) and PE 0602783A (Computer and Software Technology) / Project Y10 (Computer/Info Sci Tech) in FY20 as part of the financial restructure.</p>				
<p>Title: Smart Networks and Distributed Sensing for C3I</p> <p>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, radio frequency (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.</p> <p>FY 2020 Plans: Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602120A (Sensors and Electronic Survivability) / Project H16 (S3I Technology) and PE 0602783A (Computer and Software Technology) / Project Y10 (Computer/Info Sci Tech) in FY20 as part of the financial restructure.</p>		-	-	0.412
<p>Title: Information Processing and Analysis</p> <p>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.</p> <p>FY 2020 Plans:</p>		-	-	1.944

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AR1 / <i>Robust, Resilient and Intelligent C3I Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>Will 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; 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.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602120A (Sensors and Electronic Survivability) / Project H16 (S3I Technology) and PE 0602783A (Computer and Software Technology) / Project Y10 (Computer/Info Sci Tech) in FY20 as part of the financial restructure.</p>			
Accomplishments/Planned Programs Subtotals	-	-	8.700

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AR5 / Understanding the Environment as a Threat Technolo
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AR5: <i>Understanding the Environment as a Threat Technolo</i>	-	0.000	0.000	3.943	-	3.943	2.333	1.982	1.285	0.981	0.000	10.524

Note

In Fiscal Year (FY) 2020 this Project is 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 is transitioned 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.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Predictions of Lethal Environments/ Computational Prediction of Threats in the Operational Environment	-	-	1.577
Description: This effort delivers tools and models to the Soldier providing critical information of the operational environment allowing the Soldier to operate in, avoid, or prepare for contaminated battlefields.			
FY 2020 Plans: Will 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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602720A (Environmental Quality Technology) / Project 835 (Mil Med Environ Crit), and Project 896 (Base Fac Environ Qual) in FY20 as part of the financial restructure.			
Title: Environmental Threat Overlays for Operational Routing/Predictions of Lethal Environments	-	-	2.366

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AR5 / <i>Understanding the Environment as a Threat Technolo</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2020 Plans: Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602720A (Environmental Quality Technology) / Project 835 (Mil Med Environ Crit), and Project 896 (Base Fac Environ Qual) in FY20 as part of the financial restructure.</p>			
Accomplishments/Planned Programs Subtotals	-	-	3.943

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AR9 / Persistent Geophysical Sensing-Infrasound Tech
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AR9: <i>Persistent Geophysical Sensing-Infrasound Tech</i>	-	0.000	0.000	3.963	-	3.963	4.343	3.459	2.500	2.279	0.000	16.544

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 2018	FY 2019	FY 2020
Title: Remote Assessment of Infrastructure for Ensured Maneuver (RAFTER)	-	-	3.963
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: Will 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 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AR9 / <i>Persistent Geophysical Sensing-Infrasound Tech</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from 0602784A (Military Engineering Technology) / Project T40 (Mob/Wpns Eff Tech) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	3.963

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AT2 / Subterranean Detection and Monitoring Technology
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>AT2: Subterranean Detection and Monitoring Technology</i>	-	0.000	0.000	1.600	-	1.600	3.650	1.278	1.050	1.437	0.000	9.015

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.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Subterranean Threat Assessment by Real-time Sensing	-	-	1.600
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. This effort is coordinated with PE 0603463A.			
FY 2020 Plans: Will 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 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AT2 / <i>Subterranean Detection and Monitoring Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602784 (Military Engineering Technology) / Project T40 (Mob/Wpns Eff Tech) FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	1.600

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AT7 / Network-Enabled GeoSpatial-GEOINT Services Tech			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AT7: Network-Enabled GeoSpatial-GEOINT Services Tech	-	0.000	0.000	2.992	-	2.992	3.011	2.446	2.000	0.000	0.000	10.449

Note

In Fiscal Year (FY) 2020 this Project is 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 effort 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).

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Geo-registration, Analytical Tool Development and Visualization	FY 2018	FY 2019	FY 2020
Description: This research investigates the design and formulation of new urban terrain data models, frameworks and processes to automate the geo-registration of 3D and 2D source data (e.g. 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.	-	-	2.992
FY 2020 Plans: Will 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 alerting within the Operational Environment. Will initiate the design of an advanced 3D data processing framework			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AT7 / <i>Network-Enabled GeoSpatial-GEOINT Services Tech</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
meeting criteria for transformation of point cloud data to compact feature data models, 3D-data indexing and transmission algorithms.			
<i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort is realigned from PE 0602784A (0602784A Military Engineering Technology) / Project 855 (Topographical, Image Intel & Space) and Project T42 (Terrestrial Science Applied Research) FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	2.992

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AT9 / Tactical GeoSpatial Information Capabilities Techn
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AT9: Tactical GeoSpatial Information Capabilities Techn	-	0.000	0.000	2.771	-	2.771	4.244	1.800	1.780	0.000	0.000	10.595

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
* PE0602784A/Project 855

A. Mission Description and Budget Item Justification

This Project investigates and develops next generation geospatial analytical tools for 3D 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 9Network 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).

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: 3D Terrain Analysis	-	-	1.330
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: Will investigate and build 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 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AT9 / <i>Tactical GeoSpatial Information Capabilities Techn</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
This research effort is realigned from PE 0602784A (0602784A Military Engineering Technology) / Project 855 Topographical, Image Intel & Space as part of the financial restructure.				
Title: Airborne LiDAR		-	-	1.441
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: Will 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 2019 to FY 2020 Increase/Decrease Statement: This research effort is realigned from PE 0602784A (0602784A Military Engineering Technology) / Project 855 Topographical, Image Intel & Space as part of the financial restructure.				
Accomplishments/Planned Programs Subtotals		-	-	2.771
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				
E. Performance Metrics				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AU3 / Geospatially Enabled Operational Design Technology
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AU3: <i>Geospatially Enabled Operational Design Technology</i>	-	0.000	0.000	3.173	-	3.173	3.468	2.803	1.200	0.000	0.000	10.644

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 2018	FY 2019	FY 2020
Title: Virtual Collaborative Operational Design	-	-	1.773
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: Will research methodologies and tools to support Army Design Methodology (ADM) using digital collaboration tools to frame the problem and visualize the desired end state in a geospatial context.			
FY 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AU3 / <i>Geospatially Enabled Operational Design Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
This research effort is realigned from PE0602784A (Military Engineering Technology) / Project 855 (Topographical, Image Intel & Space) in FY20 as part of the financial restructure.				
Title: Tactical Data Analysis and Visualization		-	-	1.400
Description: This effort develops a suite of data aggregation analysis and visualization capabilities allowing commanders and staffs the capability to bridge conceptual planning (ADM) to deliberate planning Military Decision Making Process (MDMP) at echelons down to battalion.				
FY 2020 Plans: Will develop capabilities to geospatially enable strategic guidance inputs to operational design, in a digital, integrated, collaborative planning environment.				
FY 2019 to FY 2020 Increase/Decrease Statement: This research effort is realigned from PE0602784A (Military Engineering Technology) / Project 855 (Topographical, Image Intel & Space) in FY20 as part of the financial restructure.				
Accomplishments/Planned Programs Subtotals		-	-	3.173
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AU5 / Automated Analytics for Operational Environment			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AU5: Automated Analytics for Operational Environment	-	0.000	0.000	3.950	-	3.950	3.242	3.261	1.034	0.000	0.000	11.487

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 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.

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Simultaneous Multi-Domain Data Representation	FY 2018	FY 2019	FY 2020
Description: This effort investigates and develops advanced capabilities to provide commanders and staffs 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.	-	-	1.844
FY 2020 Plans: Will 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 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AU5 / <i>Automated Analytics for Operational Environment</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort is realigned from PE 0602784A (Military Engineering Technology) / Project 855 (Topographical, Image Intel & Space) in FY20 as part of the financial restructure.			
Title: Automated Analysis of Multi-Domain Data	-	-	2.106
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: Will 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 2019 to FY 2020 Increase/Decrease Statement: This research effort is realigned from PE 0602784A (Military Engineering Technology) / Project 855 (Topographical, Image Intel & Space) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	3.950

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AV5 / Protective Technologies			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AV5: Protective Technologies	-	0.000	0.000	6.800	-	6.800	7.700	7.846	6.449	6.521	0.000	35.316

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 2018	FY 2019	FY 2020
Title: Protective Technologies	-	-	6.800
Description: This effort develops tools, devices, and techniques to protect acquisition program systems and Critical Program Information (CPI) from adversarial threats.			
FY 2020 Plans: Will integrate threat-based sensors and enhance secure processor intellectual property (IP) for enhanced Rigor 1b second engineering model; manufacture full Rigor 1a engineering models; complete laboratory characterization of Rigor 1a module; and will develop the designs for Rigor 1c and Rigor 1d modules.			
FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602705A (0602705A Electronics and Electronic Devices) / Project H94 (Elect & Electronic Devices) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	6.800

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army Date: March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AV5 / <i>Protective Technologies</i>
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D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AV6 / Airborne Engineering Support Technology
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>AV6: Airborne Engineering Support Technology</i>	-	0.000	0.000	0.882	-	0.882	0.900	0.918	0.936	0.947	0.000	4.583

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)

Title: Airborne Engineering Support Technology	FY 2018	FY 2019	FY 2020
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 S&T command, control, communications, intelligence, surveillance and reconnaissance (C3ISR) portfolio.	-	-	0.882
FY 2020 Plans: Will 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 2019 to FY 2020 Increase/Decrease Statement: This research effort is realigned from PE 0602782A (Command, Control, Communications Technology / Project 779 (Command, Control and Platform Electronics Tech) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	0.882

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AV6 / Airborne Engineering Support Technology
C. Other Program Funding Summary (\$ in Millions) N/A		
Remarks		
D. Acquisition Strategy N/A		
E. Performance Metrics N/A		

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AV7 / Atmospheric Modeling and Meteorological Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>AV7: Atmospheric Modeling and Meteorological Technology</i>	-	0.000	0.000	5.812	-	5.812	5.950	6.070	6.192	6.261	0.000	30.285

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)

Title: Atmospheric Characterization, Modeling, and Impacts	FY 2018	FY 2019	FY 2020
Description: This effort develops environmental situational understanding enabled through coupled sensing, modeling, and decision support technologies for data-sparse, computationally-limited, and network-constrained domains.	-	-	5.812
FY 2020 Plans:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AV7 / <i>Atmospheric Modeling and Meteorological Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Will 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.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602784 (Military Engineering Technology) / Project H71 (Meteorological Research for Battle Command) in FY20 as part of the financial restructure.</p>				
Accomplishments/Planned Programs Subtotals		-	-	5.812
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				
E. Performance Metrics				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology				Project (Number/Name) AV9 / Advanced PNT for GPS Independent Environments Tech			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AV9: Advanced PNT for GPS Independent Environments Tech	-	0.000	0.000	6.974	-	6.974	6.662	6.838	8.743	8.841	0.000	38.058

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 research addresses the PNT Scenarios 1 (GPS operations that start good and have good 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 RF domain using innovative radio frequency (RF) antenna concepts to extend the reach of Soldier compatible capabilities in heavily contested GPS environments.

This Project also 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 7 days in a GPS denied environment. This conducts research in advanced quantum timing circuits, advanced inertial measurement unit (IMU) components, multi-sensor modalities, perception techniques, geolocation data, vision aided navigation sensors, and available RF signals.

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 2018	FY 2019	FY 2020
Title: Precision Measurement Technology for Contested Environments	-	-	3.057
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 micro-Inertial Measurement Units (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.			
FY 2020 Plans:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AV9 / <i>Advanced PNT for GPS Independent Environments Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Will refine modeling designs for novel MEMS IMU using advanced MEMS materials, cavity designs, and micro-structures; fabricate 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602705 (Electronics and Electronic Devices) / Project H94 (Elect & Electronic Dev) in FY20 as part of the financial restructure.</p>				
<p>Title: Quantum Effects for Assured PNT in Zero-GPS Environments</p> <p>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.</p> <p>FY 2020 Plans: Will 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602705 (Electronics and Electronic Devices) / Project H94 (Elect & Electronic Dev) in FY20 as part of the financial restructure.</p>		-	-	3.917
Accomplishments/Planned Programs Subtotals		-	-	6.974
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AV9 / Advanced PNT for GPS Independent Environments Tech

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>				Project (Number/Name) AW1 / <i>Autonomous Navigation Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AW1: <i>Autonomous Navigation Technology</i>	-	0.000	0.000	0.400	-	0.400	0.300	0.300	0.300	0.000	0.000	1.300

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)

Title: Autonomous Navigation Technology	FY 2018	FY 2019	FY 2020
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. Work accomplished under PE 0603463A/ Project AW2 (Autonomous Navigation Advanced Technology) complements this effort.	-	-	0.400
FY 2020 Plans: Will 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). Will develop and investigate alternative methods of UAV-based ground vehicle identification utilizing fiducial markers and deep learning algorithms. Will investigate and validate methodologies to combine UGV localization and identification algorithms through simulation.			
FY 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AW1 / <i>Autonomous Navigation Technology</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602782A (Command, Control, Communications Technology) / Project 779 (Command, Control and Platform Electronics Tech) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	0.400

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AW3 / DoD PNT M&S Collaborative Initiative (CI) Technolo
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AW3: DoD PNT M&S Collaborative Initiative (CI) Technolo	-	0.000	0.000	2.000	-	2.000	2.000	0.000	0.000	0.000	0.000	4.000

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 2018	FY 2019	FY 2020
Title: DoD PNT M&S Collaborative Initiative (CI)	-	-	2.000
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:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AW3 / <i>DoD PNT M&S Collaborative Initiative (CI) Technolo</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
Will design and develop an architecture, framework, catalogue, repository and models for complementary PNT technologies.			
<i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602782A (Command, Control, Communications Technology) / Project 779 (Command, Control and Platform Electronics Tech) in FY20 as part of the financial restructure..			
Accomplishments/Planned Programs Subtotals	-	-	2.000

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / Network C3I Technology	Project (Number/Name) AW5 / Modular GPS Independent Sensors Technology
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>AW5: Modular GPS Independent Sensors Technology</i>	-	0.000	0.000	4.140	-	4.140	4.334	4.432	4.527	4.881	0.000	22.314

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 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)

Title: Modular GPS Independent Sensors	FY 2018	FY 2019	FY 2020
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. Work accomplished under PE 0603463A/Project AW6 (Modular GPS Independent Sensors Advanced Technology) complements this effort.	-	-	4.140
FY 2020 Plans: Will continue to develop Quad Mass Gyro Inertial Measurement Units and investigate Infrared Vision Sensors for use in PNT solutions. Will develop a PNT sensor fusion core and sensor fusion modules; Will develop algorithms for PNT integrity. Will design a PNT Software Defined Receiver; Will investigate other existing sensors to be used in a PNT solution.			
FY 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602146A / <i>Network C3I Technology</i>	Project (Number/Name) AW5 / <i>Modular GPS Independent Sensors Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602782A (Command, Control, Communications Technology) / Project 779 (Command, Control and Platform Electronics Tech) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	4.140

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army											Date: March 2019	
Appropriation/Budget Activity 2040: Research, Development, Test & Evaluation, Army / BA 2: Applied Research					R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology							
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	0.000	0.000	74.327	-	74.327	74.097	81.632	85.468	88.896	0.000	404.420
AE7: Land-Based Anti-Ship Missile (LBASM) Technology	-	0.000	0.000	11.900	-	11.900	10.100	0.000	0.000	0.000	0.000	22.000
AF1: Long Range Maneuverable Fires (LRMF) Technology*	-	0.000	0.000	0.000	-	0.000	0.000	5.100	7.100	8.293	0.000	20.493
AF3: Extended Range Propulsion Technology	-	0.000	0.000	5.831	-	5.831	6.601	10.017	11.124	10.868	0.000	44.441
AF5: Simulation and Aerostructures Technology	-	0.000	0.000	1.434	-	1.434	1.461	1.490	1.520	1.537	0.000	7.442
AF6: Structures Technology	-	0.000	0.000	1.245	-	1.245	1.264	1.289	1.315	1.329	0.000	6.442
AF7: Warhead Integration Technology	-	0.000	0.000	1.752	-	1.752	1.792	2.083	2.125	2.149	0.000	9.901
AF8: Affordable Extended Range Precision Technology	-	0.000	0.000	0.300	-	0.300	0.294	1.562	1.985	1.441	0.000	5.582
AF9: Precision and Accuracy Technology	-	0.000	0.000	8.576	-	8.576	8.746	8.921	9.100	13.607	0.000	48.950
AG1: Missile Electronics Technology	-	0.000	0.000	3.148	-	3.148	3.217	3.281	3.347	3.384	0.000	16.377
AG2: Information and Signal Processing Technology	-	0.000	0.000	1.669	-	1.669	1.702	1.736	1.771	1.790	0.000	8.668
AG4: Extended Range Artillery Munition Suite Technology	-	0.000	0.000	7.092	-	7.092	6.654	5.237	5.341	5.401	0.000	29.725
AG6: Energetic Materials and Advanced Processing Techno	-	0.000	0.000	6.885	-	6.885	6.955	7.117	7.259	7.340	0.000	35.556
AG8: Advanced Energetics Technology	-	0.000	0.000	10.523	-	10.523	11.407	14.725	15.019	15.186	0.000	66.860
AG9: Multiple Simul Engagement Technologies (MSET) Tech	-	0.000	0.000	2.150	-	2.150	3.200	6.626	5.742	3.710	0.000	21.428

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity	R-1 Program Element (Number/Name)												
2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	PE 0602147A / <i>Long Range Precision Fires Technology</i>												
AH2: <i>Single Multi-mission Attack Missile (SMAM) Technol</i>	-	0.000	0.000	1.317	-	1.317	0.000	0.000	0.000	0.000	0.000	0.000	1.317
AH4: <i>Precision and Coop Weapons in a Denied Env Tech</i>	-	0.000	0.000	9.505	-	9.505	9.638	9.831	10.051	10.163	0.000	0.000	49.188
BN5: <i>Fuze and Power for Munitions</i>	-	0.000	0.000	1.000	-	1.000	1.066	2.617	2.669	2.698	0.000	0.000	10.050

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

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is realigned with continuity of effort from the following PEs:

- * 0602303A Missile Technology
- * 0602618A Ballistics Technology
- * 0602624A Weapons and Munitions Advanced Technology

A. Mission Description and Budget Item Justification

Work in this Program Element (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. 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).

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602147A / <i>Long Range Precision Fires Technology</i>
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B. Program Change Summary (\$ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	0.000	0.000	0.000	-	0.000
Current President's Budget	0.000	0.000	74.327	-	74.327
Total Adjustments	0.000	0.000	74.327	-	74.327
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	74.327	-	74.327

Change Summary Explanation

FY20 increase related to Science and Technology financial restructure.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology				Project (Number/Name) AE7 / Land-Based Anti-Ship Missile (LBASM) Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AE7: Land-Based Anti-Ship Missile (LBASM) Technology	-	0.000	0.000	11.900	-	11.900	10.100	0.000	0.000	0.000	0.000	22.000

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
 Program Element (PE) 0602303 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.

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 Army Futures Command (AFC).

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Land Based Anti-Ship Missile (LBASM) Technology	-	-	11.900
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 2019 to FY 2020 Increase/Decrease Statement: This research effort is realigned from PE 0602303A (Missile Technology) / Project 214 (Missile Technology) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	11.900

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602147A / <i>Long Range Precision Fires Technology</i>	Project (Number/Name) AE7 / <i>Land-Based Anti-Ship Missile (LBASM) Technology</i>

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology	Project (Number/Name) AF3 / Extended Range Propulsion Technology
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AF3: <i>Extended Range Propulsion Technology</i>	-	0.000	0.000	5.831	-	5.831	6.601	10.017	11.124	10.868	0.000	44.441

Note

In Fiscal Year (FY) 2020 this Project is realigned from:
 Program Element (PE) 0602303 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 Army Futures Command (AFC).

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Extended Range Propulsion Technology	-	-	5.831
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 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602147A / <i>Long Range Precision Fires Technology</i>	Project (Number/Name) AF3 / <i>Extended Range Propulsion Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602303A (Missile Technology) / Project 214 (Missile Technology) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	5.831

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology				Project (Number/Name) AF5 / Simulation and Aerostructures Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AF5: <i>Simulation and Aerostructures Technology</i>	-	0.000	0.000	1.434	-	1.434	1.461	1.490	1.520	1.537	0.000	7.442

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
 Program Element (PE) 0602303 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 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 2018	FY 2019	FY 2020
Title: Simulation and Aerostructures Technology	-	-	1.434
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: 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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602303 (Missile Technology) / Project 214 (Missile Technology) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	1.434

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology	Project (Number/Name) AF5 / Simulation and Aerostructures Technology

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology				Project (Number/Name) AF6 / Structures Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AF6: Structures Technology	-	0.000	0.000	1.245	-	1.245	1.264	1.289	1.315	1.329	0.000	6.442

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
 Program Element (PE) 0602303 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 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 2018	FY 2019	FY 2020
Title: Structures Technology	-	-	1.245
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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602303A (Missile Technology) / Project 214 (Missile Technology) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	1.245

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602147A / <i>Long Range Precision Fires Technology</i>	Project (Number/Name) AF6 / <i>Structures Technology</i>

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology				Project (Number/Name) AF7 / Warhead Integration Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AF7: Warhead Integration Technology	-	0.000	0.000	1.752	-	1.752	1.792	2.083	2.125	2.149	0.000	9.901

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 advanced warhead subsystem integration techniques for future missile systems.

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 2018	FY 2019	FY 2020
Title: Warhead Integration Technology	-	-	1.752
Description: Investigate advanced warhead subsystem integration techniques for future missile systems.			
FY 2020 Plans: 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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602303A (Missile Technology) / Project 214 Missile Technology in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	1.752

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602147A / <i>Long Range Precision Fires Technology</i>	Project (Number/Name) AF7 / <i>Warhead Integration Technology</i>

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology	Project (Number/Name) AF8 / Affordable Extended Range Precision Technology
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AF8: Affordable Extended Range Precision Technology	-	0.000	0.000	0.300	-	0.300	0.294	1.562	1.985	1.441	0.000	5.582

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, and airframes.

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 2018	FY 2019	FY 2020
Title: Affordable Extended Range Precision Technology	-	-	0.300
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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602303 (Missile Technology) / Project 214 (Missile Technology) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	0.300

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology	Project (Number/Name) AF8 / Affordable Extended Range Precision Technology

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology				Project (Number/Name) AF9 / Precision and Accuracy Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AF9: Precision and Accuracy Technology	-	0.000	0.000	8.576	-	8.576	8.746	8.921	9.100	13.607	0.000	48.950

Note

In Fiscal Year (FY) 2020 this Project is being 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 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 0603464/AE8 LBASM 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 2018	FY 2019	FY 2020
Title: Precision and Accuracy Technology	-	-	8.576
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: 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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602147A / <i>Long Range Precision Fires Technology</i>	Project (Number/Name) AF9 / <i>Precision and Accuracy Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
technology; and vision based technology that ensures accurate long range, high speed missile target engagement in jammed and complex operating environments. <i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602303 (Missile Technology) / Project 214 (Missile Technology) in FY20 as part of the financial restrudcture.			
Accomplishments/Planned Programs Subtotals	-	-	8.576

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology				Project (Number/Name) AG1 / Missile Electronics Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AG1: <i>Missile Electronics Technology</i>	-	0.000	0.000	3.148	-	3.148	3.217	3.281	3.347	3.384	0.000	16.377

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 technologies and techniques to miniaturize guidance electronics for advanced missile systems.

Work in this Project complements PE 0602147 Long Range Precision Fires Technology and PE 0603464 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 2018	FY 2019	FY 2020
Title: Missile Electronics Technology	-	-	3.148
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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602303 (Missile Technology) / Project 214 (Missile Technology) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	3.148

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602147A / <i>Long Range Precision Fires Technology</i>	Project (Number/Name) AG1 / <i>Missile Electronics Technology</i>
C. Other Program Funding Summary (\$ in Millions) N/A		
Remarks		
D. Acquisition Strategy N/A		
E. Performance Metrics N/A		

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology				Project (Number/Name) AG2 / Information and Signal Processing Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AG2: Information and Signal Processing Technology	-	0.000	0.000	1.669	-	1.669	1.702	1.736	1.771	1.790	0.000	8.668

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
 Program Element (PE) 0602303 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 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 0602147 Long Range Precision Fires Technology and PE 0603464 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 2018	FY 2019	FY 2020
Title: Information and Signal Processing Technology	-	-	1.669
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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602303A (Missile Technology) / Project 214 Missile Technology.			
Accomplishments/Planned Programs Subtotals			1.669

C. Other Program Funding Summary (\$ in Millions)

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology	Project (Number/Name) AG2 / Information and Signal Processing Technology

C. Other Program Funding Summary (\$ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology				Project (Number/Name) AG4 / Extended Range Artillery Munition Suite Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AG4: <i>Extended Range Artillery Munition Suite Technology</i>	-	0.000	0.000	7.092	-	7.092	6.654	5.237	5.341	5.401	0.000	29.725

Note

In Fiscal Year (FY) 2020 this Project was r5ealigned 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.

Work in this Project complements PE 0603464/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 2018	FY 2019	FY 2020
Title: Precision At Range Technologies	-	-	3.092
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 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 2019 to FY 2020 Increase/Decrease Statement: This effort was previously funded in PE 0602624 (Weapons and Munitions Technology) / Project H18 (Weapons and Munitions Technologies) in FY20 as part of the financial restructure.			
Title: Extended Range Artillery Munition Suite Enabling Technologies	-	-	4.000

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology	Project (Number/Name) AG4 / Extended Range Artillery Munition Suite Technology

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This effort was previously funded in PE 0602624 (Weapons and Munitions Technology) / Project H18 (Weapons and Munitions Technologies) in FY20 as part of the financial restructure.</p>			
Accomplishments/Planned Programs Subtotals	-	-	7.092

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology	Project (Number/Name) AG6 / Energetic Materials and Advanced Processing Techno
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AG6: <i>Energetic Materials and Advanced Processing Techno</i>	-	0.000	0.000	6.885	-	6.885	6.955	7.117	7.259	7.340	0.000	35.556

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
 * 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 0603464/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 2018	FY 2019	FY 2020
Title: Novel Propulsion	-	-	3.452
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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology	Project (Number/Name) AG6 / Energetic Materials and Advanced Processing Techno		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
formulation of electrically controlled energetic materials (ECEM); fund research of next generation post launch propulsion on gun launched concepts for extended range. FY 2019 to FY 2020 Increase/Decrease Statement: This effort was realigned from PE 0602624A (Weapons and Munitions Technology) / Project H18 (Weapons and Munitions Technologies) and Project H28 (Warheads/Energetics Technologies) in FY20 as part of the financial restructure.				
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 2019 to FY 2020 Increase/Decrease Statement: This effort was realigned from PE 0602624A (Weapons and Munitions Technology) / Project H18 (Weapons and Munitions Technologies) and Project H28 (Warheads/Energetics Technologies) in FY20 as part of the financial restructure.		-	-	3.433
Accomplishments/Planned Programs Subtotals		-	-	6.885
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology				Project (Number/Name) AG8 / Advanced Energetics Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AG8: <i>Advanced Energetics Technology</i>	-	0.000	0.000	10.523	-	10.523	11.407	14.725	15.019	15.186	0.000	66.860

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
 Program Element (PE) 0602624 Weapons and Munitions Technology:
 * Project H28 Warheads/Energetics 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 0602147/AG6 Energetic Materials and Advanced Processing Technology; PE 0603464/AG7 Energetic Materials and Advanced Processing 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 2018	FY 2019	FY 2020
Title: Advanced Energetics	-	-	10.523
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 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 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602147A / <i>Long Range Precision Fires Technology</i>	Project (Number/Name) AG8 / <i>Advanced Energetics Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602624A (Weapons and Munitions Technology) / Project H28 Warheads/Energetics Technology in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	10.523

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology	Project (Number/Name) AG9 / Multiple Simul Engagement Technologies (MSET) Tech
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AG9: Multiple Simul Engagement Technologies (MSET) Tech	-	0.000	0.000	2.150	-	2.150	3.200	6.626	5.742	3.710	0.000	21.428

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
 Program Element (PE) 0602303 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 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 0603464/AF4 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 2018	FY 2019	FY 2020
Title: Multiple Simultaneous Engagement Technologies (MSET) Technology	-	-	2.150
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: Will develop missile MSET system architecture and user-validated concept of operations, and conduct technology and component trade studies.			
FY 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602147A / <i>Long Range Precision Fires Technology</i>	Project (Number/Name) AG9 / <i>Multiple Simul Engagement Technologies (MSET) Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
This research effort was realigned in FY20 from PE 0602303A Missile Technology / Project 214 (Missile Technology) in FY20 as part of the financial restructure.				
Accomplishments/Planned Programs Subtotals		-	-	2.150
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology	Project (Number/Name) AH2 / Single Multi-mission Attack Missile (SMAM) Technol
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AH2: Single Multi-mission Attack Missile (SMAM) Technol	-	0.000	0.000	1.317	-	1.317	0.000	0.000	0.000	0.000	0.000	1.317

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 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 0603464/AH3 SMAM Advanced Technology and PE 0603464/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 2018	FY 2019	FY 2020
Title: Single Multi-mission Attack Missile (SMAM) Technology	-	-	1.317
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: 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 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602147A / <i>Long Range Precision Fires Technology</i>	Project (Number/Name) AH2 / <i>Single Multi-mission Attack Missile (SMAM) Technol</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602303A (Missile Technology) / Project 214 (Missile Technology) in FY20 as part of the financial restructure.			
Accomplishments/Planned Programs Subtotals	-	-	1.317

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology	Project (Number/Name) AH4 / Precision and Coop Weapons in a Denied Env Tech
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AH4: Precision and Coop Weapons in a Denied Env Tech	-	0.000	0.000	9.505	-	9.505	9.638	9.831	10.051	10.163	0.000	49.188

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 demonstrates technologies and understanding to deliver accurate fires from extended ranges in denied environments. 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/Project AA7 Mechanics and Ballistics and complements PE 0602141A Project 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 transitions products for future close- and deep-range Long Range Precision Fires capabilities (e.g., Extended Range Cannon Artillery, Precision Strike Missile) and 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.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Munition Navigation Technology in Contested Environments	-	-	5.000
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:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 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 2018	FY 2019	FY 2020
<p>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 common software/hardware-in-the-loop environment; Design guidance electronics with apertures, characterize static and dynamic performance, and validate mechanical/thermal survivability in lab.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 062618A (Ballistics Technology) / Project H80 Survivability and Lethality Technologies in FY20 as part of the financial restructure.</p>				
<p>Title: Munition Maneuvering Technology in Extreme Environments</p> <p>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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 062618A (Ballistics Technology) / Project H80 Survivability and Lethality Technologies in FY20 as part of the financial restructure.</p>		-	-	4.505
Accomplishments/Planned Programs Subtotals		-	-	9.505
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602147A / <i>Long Range Precision Fires Technology</i>	Project (Number/Name) AH4 / <i>Precision and Coop Weapons in a Denied Env Tech</i>

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology				Project (Number/Name) BN5 / Fuze and Power for Munitions			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
BN5: Fuze and Power for Munitions	-	0.000	0.000	1.000	-	1.000	1.066	2.617	2.669	2.698	0.000	10.050

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 runtime 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 2018	FY 2019	FY 2020
Title: Advanced Energetics	-	-	1.000
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 OSD Joint Munitions Program TCG - 5 and TCG-10 and the OSD Joint Fuze Technology Program.			
FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602624A (Weapons and Munition Technology) / Project H18 (Weapons and Munitions Technologies) in FY20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	1.000

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602147A / Long Range Precision Fires Technology	Project (Number/Name) BN5 / Fuze and Power for Munitions

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: Research, Development, Test & Evaluation, Army / BA 2: Applied Research	R-1 Program Element (Number/Name) PE 0602148A / Future Verticle Lift Technology
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	0.000	0.000	93.601	-	93.601	88.903	88.170	89.971	91.056	0.000	451.701
A15: Next Gen Tactical UAS TD Technology	-	0.000	0.000	9.242	-	9.242	7.577	7.668	8.233	8.340	0.000	41.060
A17: Alternative Concept Engine Technology	-	0.000	0.000	3.657	-	3.657	3.730	3.805	3.881	3.925	0.000	18.998
A19: Future UAS Engine Technology	-	0.000	0.000	2.888	-	2.888	3.054	3.227	3.372	3.487	0.000	16.028
AJ2: Next Generation Rotorcraft Transmission Technology	-	0.000	0.000	4.045	-	4.045	4.126	4.209	4.293	4.341	0.000	21.014
AJ4: Digital Vehicle Management and Control Technology	-	0.000	0.000	4.816	-	4.816	4.912	5.010	5.110	5.167	0.000	25.015
AJ6: Advanced Rotors Technology	-	0.000	0.000	2.362	-	2.362	2.422	2.480	2.532	2.535	0.000	12.331
AJ8: Experimental and Computational Aeromechanics Techn	-	0.000	0.000	5.185	-	5.185	5.274	6.217	6.456	6.631	0.000	29.763
AK1: UAS Survivability Technology	-	0.000	0.000	1.000	-	1.000	1.050	5.125	6.729	6.686	0.000	20.590
AK2: Aviation Survivability Technology	-	0.000	0.000	21.792	-	21.792	21.253	22.134	22.566	22.819	0.000	110.564
AK4: Multi-Role Small Guided Missile Technology	-	0.000	0.000	6.104	-	6.104	4.500	1.800	0.000	0.000	0.000	12.404
AK6: Advanced Rotorcraft Armaments Protection System Te	-	0.000	0.000	5.313	-	5.313	3.419	0.000	0.000	0.000	0.000	8.732
AK9: Adv Teaming for Tactical Aviation Operations Tech	-	0.000	0.000	13.583	-	13.583	13.777	12.427	12.450	12.615	0.000	64.852

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army											Date: March 2019		
Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>					R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>								
<i>AL2: High Performance Computing for Rotorcraft App Tech</i>	-	0.000	0.000	1.169	-	1.169	1.192	1.216	1.240	1.254	0.000	6.071	
<i>AL4: High Speed and Efficient VTOL Vehicle Technology</i>	-	0.000	0.000	1.500	-	1.500	1.500	1.500	1.530	1.547	0.000	7.577	
<i>AL5: Air Vehicle Structures and Dynamics Technology</i>	-	0.000	0.000	2.766	-	2.766	2.827	2.890	2.948	2.981	0.000	14.412	
<i>AL8: Holistic Situational Awareness and Dec Making Tech</i>	-	0.000	0.000	1.745	-	1.745	1.785	1.821	1.857	1.879	0.000	9.087	
<i>AM2: Aircraft and Aircrew Protection Technology</i>	-	0.000	0.000	1.522	-	1.522	1.552	1.583	1.615	1.633	0.000	7.905	
<i>AM4: Opt Energy Stg & Therm Mgmt for FVL Survivability</i>	-	0.000	0.000	4.912	-	4.912	4.953	5.058	5.159	5.216	0.000	25.298	

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

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).

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>
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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)	<u>FY 2018</u>	<u>FY 2019</u>	<u>FY 2020 Base</u>	<u>FY 2020 OCO</u>	<u>FY 2020 Total</u>
Previous President's Budget	0.000	0.000	0.000	-	0.000
Current President's Budget	0.000	0.000	93.601	-	93.601
Total Adjustments	0.000	0.000	93.601	-	93.601
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	93.601	-	93.601

Change Summary Explanation

The FY20 funding increase is related to the Science and Technology financial restructuring.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) A15 / <i>Next Gen Tactical UAS TD Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>A15: Next Gen Tactical UAS TD Technology</i>	-	0.000	0.000	9.242	-	9.242	7.577	7.668	8.233	8.340	0.000	41.060

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 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.

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.

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Next Gen Tactical Unmanned Aircraft System Technology Demonstrator Technology	FY 2018	FY 2019	FY 2020
Description: Investigates and models operational concepts to understand the effects that potential FUAS capabilities will have on air vehicle properties	-	-	9.242
FY 2020 Plans: Will continue to investigate the effects that potential FUAS capabilities might have on air vehicle design considerations such as size, system performance, survivability/vulnerability, reliability, maintainability, unit cost, and operations and sustainment (O&S) cost. Will assess potential designs to support the following operational concepts: resupply, reconnaissance, surveillance, electronic warfare, protection, medical evacuation and attack. Will explore integration of mission equipment and determine critical enabling technologies to support the potential FUAS conceptual designs.			
FY 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) A15 / <i>Next Gen Tactical UAS TD Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602211A (Aviation Technology) / Project 47A (AERON & ACFT Wpns Tech) in FY20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	9.242

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>				Project (Number/Name) A17 / <i>Alternative Concept Engine Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>A17: Alternative Concept Engine Technology</i>	-	0.000	0.000	3.657	-	3.657	3.730	3.805	3.881	3.925	0.000	18.998

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 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.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Alternative Concept Engine Technology	-	-	3.657
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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from 0602211A (Aviation Technology) / Project 47A (AERON & ACFT Wpns Tech) in FY20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	3.657

C. Other Program Funding Summary (\$ in Millions)

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) A17 / <i>Alternative Concept Engine Technology</i>

C. Other Program Funding Summary (\$ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>				Project (Number/Name) A19 / <i>Future UAS Engine Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
A19: <i>Future UAS Engine Technology</i>	-	0.000	0.000	2.888	-	2.888	3.054	3.227	3.372	3.487	0.000	16.028

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) use of 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.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Multi-fuel Capable Hybrid Electric Propulsion	-	-	2.888
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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602211A (Aviation Technology) / Project 47B (Veh Prop & Struct Tech) in FY20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	2.888

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) A19 / <i>Future UAS Engine Technology</i>

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>				Project (Number/Name) AJ2 / <i>Next Generation Rotorcraft Transmission Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>AJ2: Next Generation Rotorcraft Transmission Technology</i>	-	0.000	0.000	4.045	-	4.045	4.126	4.209	4.293	4.341	0.000	21.014

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.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Next Generation Rotorcraft Transmission Technology	-	-	4.045
Description: Design and evaluate advanced drive system component technologies to support Variable multi-speed (50-100%) and 60:1 ratio in two stage transmissions, lighter weight gearboxes, 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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602211A (Aviation Technology) / Project 47A (AERON & ACFT Wpns Tech) in FY20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	4.045

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) AJ2 / <i>Next Generation Rotorcraft Transmission Technology</i>

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>				Project (Number/Name) AJ4 / <i>Digital Vehicle Management and Control Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>AJ4: Digital Vehicle Management and Control Technology</i>	-	0.000	0.000	4.816	-	4.816	4.912	5.010	5.110	5.167	0.000	25.015

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.

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.

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Digital Vehicle Management & Control Technology	FY 2018	FY 2019	FY 2020
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 3rd generation FUAS platforms.	-	-	4.816
FY 2020 Plans: 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 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) AJ4 / <i>Digital Vehicle Management and Control Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602211A (Aviation Technology) / Project 47A (AERON & ACFT Wpns Tech) in Fy20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	4.816

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) AJ6 / <i>Advanced Rotors Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>AJ6: Advanced Rotors Technology</i>	-	0.000	0.000	2.362	-	2.362	2.422	2.480	2.532	2.535	0.000	12.331

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 matures 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.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Advanced Rotors Technology	-	-	2.362
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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602211A (Aviation Technology) / Project 47A (AERON & ACFT Wpns Tech) in FY20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	2.362

C. Other Program Funding Summary (\$ in Millions)

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) AJ6 / <i>Advanced Rotors Technology</i>

C. Other Program Funding Summary (\$ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>				Project (Number/Name) AJ8 / <i>Experimental and Computational Aeromechanics Techn</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AJ8: <i>Experimental and Computational Aeromechanics Techn</i>	-	0.000	0.000	5.185	-	5.185	5.274	6.217	6.456	6.631	0.000	29.763

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.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Experimental Aeromechanics for FVL	-	-	3.037
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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602211A (Aviation Technology) / Project 47A (AERON & ACFT Wpns Tech) in Fy20 as part of the financial restructuring.			
Title: Computational Aeromechanics for FVL	-	-	2.148

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) AJ8 / <i>Experimental and Computational Aeromechanics Techn</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>Description: Investigate experimental aeromechanics technologies and test methods for FVL.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This work was previously performed in PE 0602211A Aviation Technology / Project 47A AERON & ACFT Wpns Tech.</p>			
Accomplishments/Planned Programs Subtotals	-	-	5.185

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>				Project (Number/Name) AK1 / <i>UAS Survivability Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AK1: <i>UAS Survivability Technology</i>	-	0.000	0.000	1.000	-	1.000	1.050	5.125	6.729	6.686	0.000	20.590

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 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.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: UAS Survivability	-	-	1.000
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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602211A (Aviation Technology) / Project 47A (AERON & ACFT Wpns Tech) in FY20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	1.000

C. Other Program Funding Summary (\$ in Millions)

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) AK1 / <i>UAS Survivability Technology</i>

C. Other Program Funding Summary (\$ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>				Project (Number/Name) AK2 / <i>Aviation Survivability Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AK2: <i>Aviation Survivability Technology</i>	-	0.000	0.000	21.792	-	21.792	21.253	22.134	22.566	22.819	0.000	110.564

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
 Program Element (PE0 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.

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.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Signature Reduction for Advanced Threat	-	-	4.085
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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) AK2 / <i>Aviation Survivability Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602211A (Aviation Technology) / Project 47A (AERON & ACFT Wpns Tech) in FY20 as part of the financial restructuring.</p>				
<p>Title: Cognitive Countermeasures Technology Development</p> <p>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.</p> <p>FY 2020 Plans: Will investigate spectral and temporal radio frequency (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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602705A (Electronics and Electronic Devices) / Project H94 (Elec & Electronic Dev) in FY20 as part of the financial restructuring.</p>		-	-	2.000
<p>Title: Reconfigurable Transformational Optics/Task based Display</p> <p>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) 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.</p> <p>FY 2020 Plans:</p>		-	-	6.153

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) AK2 / <i>Aviation Survivability Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602709A (Night Vision Technology) / Project H95 (Night Vision and Electro-Optic Technology) in FY20 as part of the financial restructuring..</p>				
<p>Title: Multispectral Threat Warning and Countermeasures</p> <p>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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602270A (Electronic Warfare Technology) / Project 906 (Tactical Electronic Warfare Applied Research) in FY20 as part of the financial restructuring.</p>		-	-	7.054
<p>Title: Tunable Pyrotechnics Technologies</p> <p>Description: Develop and investigate technologies for nano, reactive, and advanced/novel materials and energetic manufacturing processes to enable, customize and ?tune? a family of Countermeasure Decoys for FVL platforms.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602624A (Weapons and Munitions Technology) / Project H28 (Warheads/Energetics Technology) in FY20 as part of the financial restructuring.</p>		-	-	2.500
Accomplishments/Planned Programs Subtotals		-	-	21.792

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) AK2 / <i>Aviation Survivability Technology</i>

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>				Project (Number/Name) AK4 / <i>Multi-Role Small Guided Missile Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AK4: <i>Multi-Role Small Guided Missile Technology</i>	-	0.000	0.000	6.104	-	6.104	4.500	1.800	0.000	0.000	0.000	12.404

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.

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.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
<p>Title: Modular Missile Technology</p> <p>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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602303A (Missile Technology) / Project 214 (Missile Technology) in FY20 as part of the financial restructuring.</p>	-	-	1.704
<p>Title: Multi-Role Guided Missile - Extended Range Technology</p> <p>Description: Design and evaluate critical technologies that provide aviation and ground launched 35+km Non-Line of Sight man-in-the-loop situational awareness and targeting loiter capability; lethal effects against hard armor; and other high-value targets;</p>	-	-	4.400

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) AK4 / <i>Multi-Role Small Guided Missile Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
and maneuverable precision strike missile systems 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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602303A (Missile Technology) / Project 214 (Missile Technology) in FY20 as part of the financial restructuring.				
Accomplishments/Planned Programs Subtotals		-	-	6.104
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) AK6 / <i>Advanced Rotorcraft Armaments Protection System Te</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>AK6: Advanced Rotorcraft Armaments Protection System Te</i>	-	0.000	0.000	5.313	-	5.313	3.419	0.000	0.000	0.000	0.000	8.732

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
 Program Element (PE) 0602624A Weapons and Munitions Technology
 * Project H18 Weapons & Munitions Technologies.

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.

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Advanced Rotorcraft Armament & Protection System (ARAPS)	FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2020 Plans: 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement:</p>	-	-	5.313

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) AK6 / <i>Advanced Rotorcraft Armaments Protection System Te</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602624A (Weapons and Munitions Technology) / Project H18 (Weapons & Munitions Technologies) in FY20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	5.313

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>				Project (Number/Name) AK9 / <i>Adv Teaming for Tactical Aviation Operations Tech</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AK9: <i>Adv Teaming for Tactical Aviation Operations Tech</i>	-	0.000	0.000	13.583	-	13.583	13.777	12.427	12.450	12.615	0.000	64.852

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.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
<p>Title: Advanced Teaming Concepts</p> <p>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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602211A (Aviation Technology) / Project 47A (AERON & ACFT Wpns Tech) in FY20 as part of the financial restructuring.</p>	-	-	9.776
<p>Title: Micro/Small Scale Unmanned Aerial Systems</p>	-	-	3.807

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) AK9 / <i>Adv Teaming for Tactical Aviation Operations Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602211A (Aviation Technology) / Project 47B (Veh Prop & Struct Tech) in FY20 as part of the financial restructuring.</p>				
Accomplishments/Planned Programs Subtotals		-	-	13.583
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				
E. Performance Metrics				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>				Project (Number/Name) AL2 / <i>High Performance Computing for Rotorcraft App Tech</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>AL2: High Performance Computing for Rotorcraft App Tech</i>	-	0.000	0.000	1.169	-	1.169	1.192	1.216	1.240	1.254	0.000	6.071

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. 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.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: High Performance Computing for Rotorcraft App Tech	-	-	1.169
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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602211A (Aviation Technology) / Project 47A (AERON & ACFT Wpns Tech) in FY20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	1.169

C. Other Program Funding Summary (\$ in Millions)

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) AL2 / <i>High Performance Computing for Rotorcraft App Tech</i>

C. Other Program Funding Summary (\$ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>				Project (Number/Name) AL4 / <i>High Speed and Efficient VTOL Vehicle Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>AL4: High Speed and Efficient VTOL Vehicle Technology</i>	-	0.000	0.000	1.500	-	1.500	1.500	1.500	1.530	1.547	0.000	7.577

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 investigates and performs computer modeling of propulsion, aeromechanics, and platform technologies to meet performance capabilities required by Future Vertical Lift (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.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: High Speed & Efficient Vertical Take-off and Landing	-	-	1.500
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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602211A (Aviation Technology) / Project 47B (Veh Prop & Struct Tech) in FY20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	1.500

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) AL4 / <i>High Speed and Efficient VTOL Vehicle Technology</i>
C. Other Program Funding Summary (\$ in Millions) N/A		
Remarks		
D. Acquisition Strategy N/A		
E. Performance Metrics N/A		

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>				Project (Number/Name) AL5 / <i>Air Vehicle Structures and Dynamics Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>AL5: Air Vehicle Structures and Dynamics Technology</i>	-	0.000	0.000	2.766	-	2.766	2.827	2.890	2.948	2.981	0.000	14.412

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 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.

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Air Vehicle Structures and Dynamics Technology	FY 2018	FY 2019	FY 2020
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.	-	-	1.766
FY 2020 Plans: 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 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) AL5 / <i>Air Vehicle Structures and Dynamics Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602211A (Aviation Technology) / Project 47B (Veh Prop & Struct Tech) in FY20 as part of the financial restructuring.				
<p>Title: Probabilistic and Damage Tolerance Methodologies</p> <p>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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602211A (Aviation Technology) / Project 47B (Veh Prop & Struct Tech) in FY20 as part of the financial restructuring.</p>		-	-	1.000
Accomplishments/Planned Programs Subtotals		-	-	2.766
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				
E. Performance Metrics				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) AL8 / <i>Holistic Situational Awareness and Dec Making Tech</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>AL8: Holistic Situational Awareness and Dec Making Tech</i>	-	0.000	0.000	1.745	-	1.745	1.785	1.821	1.857	1.879	0.000	9.087

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.

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Radar Sensing and Phenomenology	FY 2018	FY 2019	FY 2020
<p>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 United States 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.</p> <p>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</p>	-	-	1.745

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) AL8 / <i>Holistic Situational Awareness and Dec Making Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602120A (Sensors and Electronic Survivability) / Project H16 (S3I Technology) and PE 0602705A (Electronics and Electronic Devices) / Project H94 (Elec & Electronic Dev) in FY20 as part of the financial restructuring.				
Accomplishments/Planned Programs Subtotals		-	-	1.745
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>				Project (Number/Name) AM2 / <i>Aircraft and Aircrew Protection Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>AM2: Aircraft and Aircrew Protection Technology</i>	-	0.000	0.000	1.522	-	1.522	1.552	1.583	1.615	1.633	0.000	7.905

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 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.

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Aircraft & Aircrew Protection	FY 2018	FY 2019	FY 2020
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.	-	-	1.522
FY 2020 Plans: 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 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) AM2 / <i>Aircraft and Aircrew Protection Technology</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602211A (Aviation Technology) / Project 47A (AERON & ACFT Wpns Tech) in FY20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	1.522

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>				Project (Number/Name) AM4 / <i>Opt Energy Stg & Therm Mgmt for FVL Survivability</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>AM4: Opt Energy Stg & Therm Mgmt for FVL Survivability</i>	-	0.000	0.000	4.912	-	4.912	4.953	5.058	5.159	5.216	0.000	25.298

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, Intelligence, Surveillance and Reconnaissance (C4ISR) and survivability equipment that could be incorporated onto Future Vertical Lift (FVL) and other Army 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.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Optimized Energy for C4ISR Platforms	-	-	4.912
Description: This effort investigates power and thermal management associated with high power C4ISR 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 C4ISR 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 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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602148A / <i>Future Verticle Lift Technology</i>	Project (Number/Name) AM4 / <i>Opt Energy Stg & Therm Mgmt for FVL Survivability</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602705A (Electronics and Electronic Devices) / Project H11 (Tactical and Component Power Technology) in FY20 as part of the financial restructuring.				
Accomplishments/Planned Programs Subtotals		-	-	4.912
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602150A / <i>Air and Missile Defense Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	0.000	0.000	50.771	-	50.771	58.558	55.680	45.556	46.059	0.000	256.624
AC9: <i>High Energy Laser Tactical Vehicle Demonstrator Te</i>	-	0.000	0.000	11.114	-	11.114	11.358	0.000	0.000	0.000	0.000	22.472
AD2: <i>High Energy Laser (HEL) Enabling and Support Techn</i>	-	0.000	0.000	7.963	-	7.963	8.123	8.286	8.452	8.546	0.000	41.370
AD3: <i>Maneuver Air Defense Technology</i>	-	0.000	0.000	4.200	-	4.200	11.000	8.000	0.000	0.000	0.000	23.200
AD5: <i>Next Generation Fires Radar Technology</i>	-	0.000	0.000	9.256	-	9.256	9.421	9.588	8.210	8.301	0.000	44.776
AD7: <i>Missile Fire Control Sensors Technology</i>	-	0.000	0.000	1.608	-	1.608	1.640	1.673	1.706	1.725	0.000	8.352
AD9: <i>Close Combat High Energy Laser Technology</i>	-	0.000	0.000	7.357	-	7.357	8.705	20.374	21.029	21.263	0.000	78.728
AE2: <i>Unconventional Countermeasures-Survivability Tech</i>	-	0.000	0.000	5.756	-	5.756	4.719	3.840	2.162	2.182	0.000	18.659
AE4: <i>Collaborative ISR Sensors Technology</i>	-	0.000	0.000	3.517	-	3.517	3.592	3.919	3.997	4.042	0.000	19.067

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is 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

A. Mission Description and Budget Item Justification

Work in this Program Element (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

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602150A / <i>Air and Missile Defense Technology</i>
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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 Gun-Based Air Defense 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) and the United States Army Space and Missile Defense Command/Army Strategic Forces Command (SMDC/ARSTRAT).

B. Program Change Summary (\$ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	0.000	0.000	0.000	-	0.000
Current President's Budget	0.000	0.000	50.771	-	50.771
Total Adjustments	0.000	0.000	50.771	-	50.771
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	50.771	-	50.771

Change Summary Explanation

FY20 increase related to science and technology financial restructuring.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602150A / Air and Missile Defense Technology				Project (Number/Name) AC9 / High Energy Laser Tactical Vehicle Demonstrator Te			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AC9: High Energy Laser Tactical Vehicle Demonstrator Te	-	0.000	0.000	11.114	-	11.114	11.358	0.000	0.000	0.000	0.000	22.472

Note

In Fiscal Year (FY) 2020 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 a 100 kilowatt (kW)-class, mobile high energy laser (HEL) weapon system to protect fixed and semi-fixed sites from Rocket, Artillery, and Mortars (RAM) and UAS threats. The project researches advanced technologies for HEL weapon systems to enable more efficient laser systems with greater power output, which in-turn enables future 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.

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 United States Army Space and Missile Defense Command/Army Strategic Forces Command (SMDC/ARSTRAT).

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: High Energy Laser Tactical Vehicle Demonstrator Technology	-	-	11.114
Description: This effort develops technologies for more robust beam control and solid state laser (SSL) subsystems for the HEL Tactical Vehicle Demonstrator (TVD). Beam control technologies are to enable lighter, more agile beam control systems that are robust enough to be used in tactical Army platforms. SSL development is to increase SSL efficiencies, which will lead to reductions in size, weight and power (SWaP) requirements improving the ability to integrate SSL systems into multiple Army weapon platforms.			
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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602150A / <i>Air and Missile Defense Technology</i>	Project (Number/Name) <i>AC9 / High Energy Laser Tactical Vehicle Demonstrator Te</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602307A (Advanced Weapons Technology) / Project 042 (High Energy Laser Technology) in FY 20 as part of the financial restructuring.				
Accomplishments/Planned Programs Subtotals		-	-	11.114
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602150A / Air and Missile Defense Technology				Project (Number/Name) AD2 / High Energy Laser (HEL) Enabling and Support Techn			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AD2: High Energy Laser (HEL) Enabling and Support Techn	-	0.000	0.000	7.963	-	7.963	8.123	8.286	8.452	8.546	0.000	41.370

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
 Program Element (FY) 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. Solid State Laser (SSL) efforts continue to leverage other funds provided by the HEL Joint Technology Office , the Air Force, and the Navy to develop multiple technical approaches that reduce program risk and maintain competition. 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.

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 / Army Strategic Forces Command (SMDC/ARSTRAT) and the United States Army Futures Command (AFC).

B. Accomplishments/Planned Programs (\$ in Millions)

Title: High Energy Laser Enabling and Support Technology	FY 2018	FY 2019	FY 2020
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 other technical core competencies.	-	-	6.774
FY 2020 Plans:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 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 2018	FY 2019	FY 2020
<p>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 Tactical Vehicle Demonstrator (TVD) and Multi-Mission High Energy Laser (MMHEL). Will begin data collection on vulnerability of manned fixed- and rotary-wing aircraft components.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602705A (Electronics and Electronic Devices) / Project EM8 (High Power And Energy Component Technology) in FY20 as part of the financial restructuring.</p>				
<p>Title: High Energy Laser (HEL) Enabling Technologies for Tactical Directed Energy Weapons</p> <p>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.</p> <p>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 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602705A (Electronics and Electronic Devices) / Project EM8 (High Power And Energy Component Technology) in FY20 as part of the financial restructuring.</p>		-	-	1.189
Accomplishments/Planned Programs Subtotals		-	-	7.963
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				
E. Performance Metrics				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602150A / Air and Missile Defense Technology				Project (Number/Name) AD3 / Maneuver Air Defense Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AD3: <i>Maneuver Air Defense Technology</i>	-	0.000	0.000	4.200	-	4.200	11.000	8.000	0.000	0.000	0.000	23.200

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 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 Rotary Wing (RW), Tactical / Lethal Unmanned Aerial System (UAS), and Fixed Wing (FW) 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 2018	FY 2019	FY 2020
Title: Maneuver Air Defense Technology	-	-	4.200
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 Maneuver Short Range Air Defense (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 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602150A / <i>Air and Missile Defense Technology</i>	Project (Number/Name) AD3 / <i>Maneuver Air Defense Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from Program Element (PE) 0602303A (Missile Technology) / Project 214 (Missile Technology) in FY20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	4.200

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602150A / Air and Missile Defense Technology				Project (Number/Name) AD5 / Next Generation Fires Radar Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AD5: Next Generation Fires Radar Technology	-	0.000	0.000	9.256	-	9.256	9.421	9.588	8.210	8.301	0.000	44.776

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 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)

Title: Advanced Fire Control Radar Technologies	FY 2018	FY 2019	FY 2020
Description: This effort develops advanced radar technologies for insertion into Multi- Mission Army Radar systems	-	-	4.000
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;			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602150A / <i>Air and Missile Defense Technology</i>	Project (Number/Name) AD5 / <i>Next Generation Fires Radar Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602303A (Missile Technology) / Project 214 (Missile Technology) in FY20 as part of the financial restructuring.				
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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602120A (Sensors and Electronic Survivability) / Project H16 (S3I Technology) in FY20 as part of the financial restructuring.		-	-	1.510
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: 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		-	-	3.746

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602150A / <i>Air and Missile Defense Technology</i>	Project (Number/Name) AD5 / <i>Next Generation Fires Radar Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
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. <i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602705A (Electronics and Electronic Devices) / Project H94 (Elect & Electronic Devices) in Fy20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	9.256

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602150A / Air and Missile Defense Technology				Project (Number/Name) AD7 / Missile Fire Control Sensors Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AD7: <i>Missile Fire Control Sensors Technology</i>	-	0.000	0.000	1.608	-	1.608	1.640	1.673	1.706	1.725	0.000	8.352

Note

In Fiscal Year (FY) 2020 this Project was realigned from:
 Program Element (PE) 0602303 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 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 2018	FY 2019	FY 2020
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 and discrimination based on emerging threat information, advanced capabilities of emerging sensors, and future interceptor capabilities.			
FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602303A (Missile Technology) / Project 214 (Missile Technology) in Fy20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	1.608

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602150A / Air and Missile Defense Technology	Project (Number/Name) AD7 / Missile Fire Control Sensors Technology

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602150A / Air and Missile Defense Technology				Project (Number/Name) AD9 / Close Combat High Energy Laser Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AD9: <i>Close Combat High Energy Laser Technology</i>	-	0.000	0.000	7.357	-	7.357	8.705	20.374	21.029	21.263	0.000	78.728

Note

In Fiscal Year (FY) 2020 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 effort 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.

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 Army Space and Missile Defense Command / Army Strategic Forces Command (SMDC/ARSTRAT).

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Close Combat High Energy Laser Technology	-	-	7.357
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 tactical vehicles. Extremely low SWaP laser systems will expand the laser weapons? mission set. One goal is to have Maneuver-Short Range Air Defense laser systems on the Joint Light Tactical Vehicle (JLTV) that can protect light forces from rocket, artillery, mortar (RAM) and unmanned aerial systems (UAS). 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:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602150A / <i>Air and Missile Defense Technology</i>	Project (Number/Name) AD9 / <i>Close Combat High Energy Laser Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
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. <i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602307A (Advanced Weapons Technology) / Project 042 (High Energy Laser Technology) in Fy20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	7.357

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602150A / Air and Missile Defense Technology	Project (Number/Name) AE2 / Unconventional Countermeasures-Survivability Tech
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>AE2: Unconventional Countermeasures-Survivability Tech</i>	-	0.000	0.000	5.756	-	5.756	4.719	3.840	2.162	2.182	0.000	18.659

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 supports the Army Science and Technology Air and Missile Defense Portfolio. This work is fully coordinated with and complementary to 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 Engineer Research and Development Center (ERDC) and coordinated with the Army Futures Command (AFC).

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Development of Unconventional Countermeasures for Enhanced Survivability (DeUCES)	-	-	3.204
Description: This effort investigates and develops countermeasures to defeat near-peer advanced weapons through computational modeling and enhanced tonedown measures.			
FY 2020 Plans: Will 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 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602150A / <i>Air and Missile Defense Technology</i>	Project (Number/Name) AE2 / <i>Unconventional Countermeasures-Survivability Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602784A (Military Engineering Technology) / Project T40 (Mob/Wpns Eff Tech) in Fy20 as part of the financial restructuring.				
Title: Model-Based Assessment of Sensors and Countermeasures		-	-	2.552
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: Will develop sensor models for EO/IR sensors and generate imagery for machine learning tools; will develop and optimize an initial unconventional countermeasure capability.				
FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602784A (Military Engineering Technology) / Project T40 (Mob/Wpns Eff Tech) in Fy20 as part of the financial restructuring.				
Accomplishments/Planned Programs Subtotals		-	-	5.756
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602150A / Air and Missile Defense Technology				Project (Number/Name) AE4 / Collaborative ISR Sensors Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
AE4: Collaborative ISR Sensors Technology	-	0.000	0.000	3.517	-	3.517	3.592	3.919	3.997	4.042	0.000	19.067

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 2018	FY 2019	FY 2020
Title: Collaborative ISR Sensors Technology	-	-	3.517
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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602270A (Electronic Warfare Technology) / Project 906 (Tactical Electronic Warfare Applied Research) in FY20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	3.517

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602150A / Air and Missile Defense Technology	Project (Number/Name) AE4 / Collaborative ISR Sensors Technology

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: Research, Development, Test & Evaluation, Army / BA 2: Applied Research	R-1 Program Element (Number/Name) PE 0602211A / Aviation Technology
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	72.170	81.805	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	153.975
47A: AERON & ACFT Wpns Tech	-	54.490	53.851	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	108.341
47B: Veh Prop & Struct Tech	-	10.180	10.954	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	21.134
47C: ROTORCRAFT COMPONENT TECHNOLOGIES (CA)	-	7.500	17.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	24.500

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 Program Element (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).

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602211A / <i>Aviation Technology</i>
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B. Program Change Summary (\$ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	66.086	64.847	61.594	-	61.594
Current President's Budget	72.170	81.805	0.000	-	0.000
Total Adjustments	6.084	16.958	-61.594	-	-61.594
• Congressional General Reductions	-0.029	-0.042			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	7.500	17.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.387	-			
• Adjustments to Budget Years	-	-	-61.594	-	-61.594

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: 47C: ROTORCRAFT COMPONENT TECHNOLOGIES (CA)

- Congressional Add: *Adaptive Digital Automated Pilotage Technology (ADAPT)*
- Congressional Add: *Aviation Technology Transfer and Innovation Technology*
- Congressional Add: *Adaptive Flight Control Technology Development*
- Congressional Add: *Aviation and Missile Technology Transfer and Innovation*
- Congressional Add: *UH-60 Main Rotor Blade Modernization*

	FY 2018	FY 2019
	2.500	-
	5.000	-
	-	7.000
	-	5.000
	-	5.000
Congressional Add Subtotals for Project: 47C	7.500	17.000
Congressional Add Totals for all Projects	7.500	17.000

Change Summary Explanation

FY19 increase related to Congressional Adds totaling \$17.000 million
 FY20 decrease related to Science and Technology financial restructuring.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602211A / Aviation Technology				Project (Number/Name) 47A / AERON & ACFT Wpns Tech			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
47A: AERON & ACFT Wpns Tech	-	54.490	53.851	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	108.341

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 2018	FY 2019	FY 2020
Title: Platform Design & Structures Technologies	10.619	3.897	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019	
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602211A / Aviation Technology	Project (Number/Name) 47A / AERON & ACFT Wpns Tech	
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019
<p>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.</p> <p>FY 2019 Plans: Conduct aircraft system conceptual design research of advanced manned and unmanned platforms. Analyze and assess viability and potential performance of Next Generation Tactical UAS (NGTUAS) and other manned and unmanned system designs. Conduct conceptual trade studies and analyses to refine the Model Performance Specification for NGTUAS. Develop decision support tools to be incorporated into the integrated design environment to perform rapid trade space exploration and conduct technology and requirement sensitivity analyses. Investigate conceptual design methodologies to assess uncertainty and reliability within the integrated design environment. Further develop improved stress and load prediction capability that more accurately determines structural loads resulting from aerodynamic loads. Explore biology-inspired, light-weight concepts that enable efficient, reliable, lighter weight platform structures.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This effort realigned to PE 0602148A (Future Vertical Lift Technology) / Projects AI5 (Next Gen Tactical UAS TD Technology) and Project AM2 (Aircraft and Aircrew Protection Technology) in FY20 as part of the financial restructuring.</p>			
<p>Title: Rotors & Vehicle Management Technologies</p> <p>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.</p> <p>FY 2019 Plans: Conduct investigation of winged-compound aeromechanics and technologies; conduct fundamental computational and experimental investigation of rotor blade structural loads; develop and improve flow measurement techniques such as infra-red thermography for flow transition measurement; examine interactional aerodynamic effects on of multi-rotor configurations including the rotor downwash/outwash; investigate advanced vertical lift aircraft configurations using both high-fidelity and mid/low fidelity computational methods; validate computational aeromechanics models against wind tunnel and flight test data. Investigate advanced hub and rotor concepts for high speed flight. Explore technologies that enable high performance Unmanned Aircraft Systems (UAS) rotors and propulsors. Develop and release an integrated flight simulation modeling tool that transforms or stitches a few specific frequency-domain flight data points into a full-flight non-linear model. Investigate an initial set of Unmanned Aerial Vehicle (UAV) handling qualities and UAV flight control design and test methods. Conduct flight test research to: develop</p>		10.332	10.855
			-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602211A / Aviation Technology	Project (Number/Name) 47A / AERON & ACFT Wpns Tech		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>criteria for active inceptors; confirm techniques for improving measurements of rotor states for feedback to the flight control system; and new Mission Task Elements for high-speed configurations.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This effort realigned to PE 0602148A (Future Vertical Lift Technology) / Project AJ4 (Digital Vehicle Management and Control Technology), Project AJ6 (Advanced Rotors Technology), Project AJ8 (Experimental and Computational Aeromechanics Techn), and Project AL2 (High Performance Computing for Rotorcraft App Tech) in FY20 as part of the financial restructuring.</p>				
<p>Title: Engine and Drives Technologies</p> <p>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</p> <p>FY 2019 Plans: Continue investigation of alternative adaptable engine components in support of the high performance alternative concept engine program and Future Vertical Lift/Future Tactical Unmanned Aircraft Systems; initiate design of high reduction ratio component concepts to provide improved drive system horsepower to weight and life capability to Future Vertical Lift aircraft.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This effort realigned to PE 0602148 (Future Vertical Lift Technology) / Projects AI7 (Alternative Concept Engine Technology), and AJ2 (Next Generation Rotorcraft Transmission Technology) in FY20 as part of the financial restructuring.</p>		6.664	7.392	-
<p>Title: Survivability For Degraded Visual Environment (DVE) Operations</p> <p>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.</p> <p>FY 2019 Plans: Finalize Obstacle Field Navigation (OFN), Safe Landing Area Determination (SLAD) guidance that includes auto landing capability, and sensor driven guidance to enroute and multiple helicopter landing zone selection. Technologies in this area transition to Survivability For Degraded Visual Environment (DVE) Operations efforts in PE 0603003A (Aviation Advanced Technology), Project 313 (Adv Rotarywing Veh Tech).</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This effort ends in FY 2019.</p>		8.500	0.489	-
<p>Title: Aircraft and Occupant Survivability Technologies</p>		6.448	-	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602211A / <i>Aviation Technology</i>	Project (Number/Name) 47A / <i>AERON & ACFT Wpns Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
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.				
Title: Aircraft Weapon & Sensor Technologies		1.654	-	-
Description: Design and develop innovative approaches for integrating advanced weapons and sensors on aircraft platforms, including smart dispensers, data transfer, and post-launch weapon communication.				
Title: Mission Systems		-	11.643	-
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.				
FY 2019 Plans: Investigate adaptive Infrared (IR) engine suppression systems for future Army aircraft in an engine test cell to evaluate engine and IR suppression performance. Continue maturation of signature management technologies for Future Vertical Lift (FVL). Develop modeling and simulation tools to support survivability analysis against advanced threat systems. Define, develop and assess advanced engagement concepts for exploitation of organically launch systems off of Army aviation platforms. Investigate platform integration, mission systems, and survivability requirements to enable organically launch system engagements from Army aviation platforms.				
FY 2019 to FY 2020 Increase/Decrease Statement: This effort realigned to PE 0602148A (Future Vertical Lift Technology) / Project AI5 (Next Gen Tactical UAS TD Technology) and Project AK2 (Aviation Survivability Technology) in FY20 as part of the financial restructuring.				
Title: Unmanned and Optionally Manned Technologies		6.427	18.472	-
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 UAS components to support goal of improved UAS performance. When applicable, technologies in this area are leveraged to support mitigation of DVE.				
FY 2019 Plans: Continue to investigate management of aircrew workloads throughout mission execution, to include advanced teaming. Continue to develop algorithms for increased air platform autonomy and contingency management to support mission execution independent of a constant data link to a ground control station. Investigate and evaluate human/machine interface technologies				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602211A / <i>Aviation Technology</i>	Project (Number/Name) 47A / <i>AERON & ACFT Wpns Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
that enable reduced workloads, increased situational understating, and maximize human/machine performance in an aviation environment. Evaluate technologies to support the following capabilities; resupply, reconnaissance, surveillance, electronic warfare, protection, medical evacuation and attack. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was been realigned to PE 0602148A (Future Vertical Lift Technology) / Project AJ6 (Advanced Rotors Technology), Project AJ6 (Advanced Rotors Technology), and Project AK9 (Adv Teaming for Tactical Aviation Operations) in FY20 as part of the financial restructuring.				
Title: Maintainability & Sustainability Technologies Description: Enables highly reliable, low maintenance platforms that can survive un-sustained in the multi-domain battle space for extended periods. Explores enabling technologies comprising aircraft health state awareness, data driven sustainment approaches, and operationally durable designs.		3.846	-	-
Title: FY 2019 SBIR / STTR Transfer Description: FY 2019 SBIR / STTR Transfer FY 2019 Plans: FY 2019 SBIR / STTR Transfer FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer		-	1.103	-
Accomplishments/Planned Programs Subtotals		54.490	53.851	-
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602211A / Aviation Technology				Project (Number/Name) 47B / Veh Prop & Struct Tech			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
47B: Veh Prop & Struct Tech	-	10.180	10.954	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	21.134

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 S&T focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
<p>Title: Rotor and Structure Technology</p> <p>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.</p> <p>FY 2019 Plans: Explore techniques for coalescing data from structural sensors, novel damage models, and advanced multifunctional material systems for extreme light weighting. Improve aero elasticity modeling, along with uncertainty quantification and propagation across requirements, design variables, and technology maturity level will be investigated to enable air vehicle design. Technology enablers such as self-responsive materials/structures, three-dimensional topology optimization, and machine learning are being investigated to improve reliable and durable vehicle components.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement:</p>	2.269	2.635	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602211A / <i>Aviation Technology</i>	Project (Number/Name) 47B / <i>Veh Prop & Struct Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
This research effort was realigned to PE 0602148A (Future Vertical Lift Technology) / Project AL5 (Air Vehicle Structures and Dynamics Technology) in FY20 as part of the financial restructuring.				
<p>Title: Air Vehicle Propulsion and Power Technology (previously titled: Engine and Drive Train Technology)</p> <p>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.</p> <p>FY 2019 Plans: Conduct research that leads to enhancements in propulsion including material improvements for high temperature engine and high stress drivetrains, reliable air and fuel delivery components for robust energy conversion of multiple fuel inputs in small engine systems, and aerodynamic performance in high efficiency centrifugal compressors. Investigate more accurate simulations capable of predicting nonlinear and shifting dynamics and damage in complex and variable speed helicopter drivetrains. Techniques for interactive trade space navigation across performance, cost and capabilities are being investigated, which ties user value measures to performance and effectiveness.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This effort is ending in FY 2019.</p>		1.502	1.968	-
<p>Title: Micro/Small Scale Unmanned Aerial Systems</p> <p>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.</p> <p>FY 2019 Plans: Develop the underlying aerodynamic models that will enable small Unmanned Aircraft System (UAS) to perform aggressive maneuver through complex environments, where the incorporation of higher fidelity methods into computationally efficient physics based modeling tools will enable the design of novel UAS concepts. Carry out research that will enable advanced speed, endurance, payload capability, and on-demand design and fabrication of small-mission based UAS.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602148A (Future Vertical Lift Technology) / Project AK9 (Adv Teaming for Tactical Aviation Operations Tech) in FY20 as part of the financial restructuring.</p>		4.009	3.638	-
<p>Title: Aviation Component Failure Modeling</p>		1.000	0.974	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602211A / <i>Aviation Technology</i>	Project (Number/Name) 47B / <i>Veh Prop & Struct Tech</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2019 Plans: Develop probabilistic models that will enable the prediction of useful life of advanced propulsion materials and components and failure prediction in aviation materials and structural components. Material and structural information can be used to inform damage-adaptive maneuvers in real-time.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This effort is ending in FY 2019</p>			
<p>Title: High Speed & Efficient Vertical Take-off and Landing</p> <p>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.</p> <p>FY 2019 Plans: Conduct research in the areas of propulsion and active/passive platform technology that will enable improved reliability, efficiency, and stability of VTOL vehicles. This includes research in emerging propulsion technology such as hybrid-electric concepts, and lightweight power distribution configuration, as well as in aeromechanics research to enable higher speeds and greater efficiency for reconfigurable rotor systems. Embedded sensing, actuation, and control methods are also being investigated.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602148A (Future Vertical Lift Technology) / Project AL4 (High Speed and Efficient VTOL Vehicle Technology) in FY20 as part of the financial restructuring.</p>	1.400	1.461	-
<p>Title: FY 2019 SBIR / STTR Transfer</p> <p>Description: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 Plans: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement:</p>	-	0.278	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602211A / <i>Aviation Technology</i>	Project (Number/Name) 47B / <i>Veh Prop & Struct Tech</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
FY 2019 SBIR / STTR Transfer			
Accomplishments/Planned Programs Subtotals	10.180	10.954	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602211A / Aviation Technology	Project (Number/Name) 47C / ROTORCRAFT COMPONENT TECHNOLOGIES (CA)
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
47C: ROTORCRAFT COMPONENT TECHNOLOGIES (CA)	-	7.500	17.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	24.500

Note

Congressional Increase for Fiscal Year (FY) 2018 & FY19.

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Rotorcraft Component Technologies.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019
Congressional Add: Adaptive Digital Automated Pilotage Technology (ADAPT)	2.500	-
FY 2018 Accomplishments: Adaptive Digital Automated Pilotage Technology (ADAPT)		
Congressional Add: Aviation Technology Transfer and Innovation Technology	5.000	-
FY 2018 Accomplishments: Aviation Technology Transfer and Innovation Technology		
Congressional Add: Adaptive Flight Control Technology Development	-	7.000
FY 2019 Plans: Adaptive Flight Control Technology Development		
Congressional Add: Aviation and Missile Technology Transfer and Innovation	-	5.000
FY 2019 Plans: Aviation and Missile Technology Transfer and Innovation		
Congressional Add: UH-60 Main Rotor Blade Modernization	-	5.000
FY 2019 Plans: UH-60 Main Rotor Blade Modernization		
Congressional Adds Subtotals	7.500	17.000

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602211A / Aviation Technology	Project (Number/Name) 47C / ROTORCRAFT COMPONENT TECHNOLOGIES (CA)

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602213A / <i>C3I Applied Cyber</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	0.000	0.000	18.947	-	18.947	21.718	20.923	21.675	22.142	0.000	105.405
2CY: <i>Information Trust Technology</i>	-	0.000	0.000	1.222	-	1.222	1.221	0.516	1.011	0.996	0.000	4.966
3CY: <i>Network Access and Effects Technology</i>	-	0.000	0.000	3.945	-	3.945	4.195	6.733	6.888	6.965	0.000	28.726
5CY: <i>Offensive Cyber Operations (OCO) Mirror Technology</i>	-	0.000	0.000	1.000	-	1.000	1.000	1.000	1.000	1.011	0.000	5.011
CY1: <i>Information Assurance and Network Resiliency Tech</i>	-	0.000	0.000	3.357	-	3.357	3.491	3.476	3.879	4.149	0.000	18.352
CY6: <i>Autonomous Cyber Technology</i>	-	0.000	0.000	3.733	-	3.733	6.139	4.292	2.657	2.801	0.000	19.622
CY8: <i>Cyber Security App Research and Exper Partner Tech</i>	-	0.000	0.000	2.733	-	2.733	2.788	2.844	2.901	2.933	0.000	14.199
CY9: <i>Decoy and Deterrence Technology</i>	-	0.000	0.000	2.957	-	2.957	2.884	2.062	3.339	3.287	0.000	14.529

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 Project
- * 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 investigate 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.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602213A / C3I Applied Cyber
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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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	0.000	0.000	0.000	-	0.000
Current President's Budget	0.000	0.000	18.947	-	18.947
Total Adjustments	0.000	0.000	18.947	-	18.947
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	18.947	-	18.947

Change Summary Explanation

FY20 increase related to Science and Technology financial restructuring.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602213A / C3I Applied Cyber				Project (Number/Name) 2CY / Information Trust Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
2CY: Information Trust Technology	-	0.000	0.000	1.222	-	1.222	1.221	0.516	1.011	0.996	0.000	4.966

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 2018	FY 2019	FY 2020
Title: Information Trust Technology	-	-	1.222
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 2019 to FY 2020 Increase/Decrease Statement: FY 2020 funds are realigned from PE 0602782A Command, Control, Communications Technology/Project CY2 as part of the financial restructure and in support of Army Modernization Priorities.			
Accomplishments/Planned Programs Subtotals	-	-	1.222

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army Date: March 2019

Appropriation/Budget Activity	R-1 Program Element (Number/Name)	Project (Number/Name)
2040 / 2	PE 0602213A / C3I Applied Cyber	2CY / Information Trust Technology

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602213A / C3I Applied Cyber				Project (Number/Name) 3CY / Network Access and Effects Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
3CY: Network Access and Effects Technology	-	0.000	0.000	3.945	-	3.945	4.195	6.733	6.888	6.965	0.000	28.726

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 U.S. Army Futures Command.

Fiscal Year (FY) 2020 realignments are due to financial restructuring in support of Army Modernization Priorities.

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Applied OCO Techniques and Analytics	FY 2018	FY 2019	FY 2020
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.	-	-	3.945
FY 2020 Plans: Will 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 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602213A / <i>C3I Applied Cyber</i>	Project (Number/Name) <i>3CY / Network Access and Effects Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602270A (Electronic Warfare Technology) / Project CYB (Applied Offensive Cyber) in FY20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	3.945

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602213A / C3I Applied Cyber	Project (Number/Name) 5CY / Offensive Cyber Operations (OCO) Mirror Technology
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
5CY: Offensive Cyber Operations (OCO) Mirror Technology	-	0.000	0.000	1.000	-	1.000	1.000	1.000	1.000	1.011	0.000	5.011

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 2018	FY 2019	FY 2020
Title: Offensive Cyber Operations Mirror Technology	-	-	1.000
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: 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 2019 to FY 2020 Increase/Decrease Statement:			

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602213A / <i>C3I Applied Cyber</i>	Project (Number/Name) <i>5CY I Offensive Cyber Operations (OCO)</i> <i>Mirror Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602270A (Electronic Warfare Technology) / Project CYB (Applied Offensive Cyber) in FY20 as part of the financial restructuring..			
Accomplishments/Planned Programs Subtotals	-	-	1.000

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602213A / C3I Applied Cyber	Project (Number/Name) CY1 / Information Assurance and Network Resiliency Tech
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
CY1: <i>Information Assurance and Network Resiliency Tech</i>	-	0.000	0.000	3.357	-	3.357	3.491	3.476	3.879	4.149	0.000	18.352

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.

Fiscal Year (FY) 2020 realignments are due to financial restructuring in support of Army Modernization Priorities.

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Information Assurance and Network Resiliency Technology	FY 2018	FY 2019	FY 2020
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.	-	-	3.357
FY 2020 Plans: Will 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 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602213A / <i>C3I Applied Cyber</i>	Project (Number/Name) CY1 / <i>Information Assurance and Network Resiliency Tech</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602783A (Computer and Software Technology) / Project Y10 (Computer/Info Sci Tech) in FY20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	3.357

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602213A / C3I Applied Cyber				Project (Number/Name) CY6 / Autonomous Cyber Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
CY6: <i>Autonomous Cyber Technology</i>	-	0.000	0.000	3.733	-	3.733	6.139	4.292	2.657	2.801	0.000	19.622

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 FY 2020 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 2018	FY 2019	FY 2020
Title: Autonomous Cyber Technology	-	-	3.733
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 2019 to FY 2020 Increase/Decrease Statement: This research effort is realigned from PE 0602782A (Command, Control, Communications Technology) / Project CY2 (Applied Defensive Cyber in FY20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	3.733

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602213A / C3I Applied Cyber	Project (Number/Name) CY6 / Autonomous Cyber Technology

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602213A / C3I Applied Cyber				Project (Number/Name) CY8 / Cyber Security App Research and Exper Partner Tech			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
CY8: Cyber Security App Research and Exper Partner Tech	-	0.000	0.000	2.733	-	2.733	2.788	2.844	2.901	2.933	0.000	14.199

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 2018	FY 2019	FY 2020
Title: Cyber Security Applied Research & Experimentation Partner (AREP) Technology	-	-	2.733
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: Will 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; will 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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602213A / C3I Applied Cyber	Project (Number/Name) CY8 / Cyber Security App Research and Exper Partner Tech

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
can reason on adversarial intent and potential predict adversary next move.			
<i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602782A (Command, Control, Communications Technology) / Project CY2 (Applied Defensive Cyber) in FY20 as a result of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	2.733

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602213A / C3I Applied Cyber				Project (Number/Name) CY9 / Decoy and Deterrence Technology			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
CY9: Decoy and Deterrence Technology	-	0.000	0.000	2.957	-	2.957	2.884	2.062	3.339	3.287	0.000	14.529

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 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 2018	FY 2019	FY 2020
Title: Decoy and Deterrence Technology	-	-	2.957
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: Will investigate concepts and mechanisms utilizing pattern matching algorithms and steganographic authentication; and will 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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602782A (Command, Control, Communications Technology) / Project CY2 (Applied Defensive Cyber) in FY20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	2.957

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602213A / <i>C3I Applied Cyber</i>	Project (Number/Name) CY9 / <i>Decoy and Deterrence Technology</i>
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C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602270A / <i>Electronic Warfare Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	33.683	25.558	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	59.241
475: <i>ELECTRONIC WARFARE COMPONENT TECHNOLOGIES (CA)</i>	-	7.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	7.000
906: <i>Tactical Electronic Warfare Applied Research</i>	-	26.683	20.197	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	46.880
CYB: <i>Applied Offensive Cyber</i>	-	0.000	5.361	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.361

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.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602270A / <i>Electronic Warfare Technology</i>
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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 (Command, Control and Communications 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).

B. Program Change Summary (\$ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	27.144	25.571	26.008	-	26.008
Current President's Budget	33.683	25.558	0.000	-	0.000
Total Adjustments	6.539	-0.013	-26.008	-	-26.008
• Congressional General Reductions	-0.009	-0.013			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	7.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.452	-			
• Adjustments to Budget Years	-	-	-26.008	-	-26.008

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: 475: *ELECTRONIC WARFARE COMPONENT TECHNOLOGIES (CA)*

Congressional Add: *Congressional Program Increase*

	FY 2018	FY 2019
	7.000	-
Congressional Add Subtotals for Project: 475	7.000	-
Congressional Add Totals for all Projects	7.000	-

Change Summary Explanation

FY18 Congressional add of \$7 Million.

FY20 PE realigned due to Science and Technology financial restructuring.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602270A / <i>Electronic Warfare Technology</i>	Project (Number/Name) 475 / <i>ELECTRONIC WARFARE COMPONENT TECHNOLOGIES (CA)</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
475: <i>ELECTRONIC WARFARE COMPONENT TECHNOLOGIES (CA)</i>	-	7.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	7.000

Note

Fiscal Year (FY) 2018 Congressional Increase.

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Electronic Warfare technology applied research.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019
Congressional Add: Congressional Program Increase	7.000	-
FY 2018 Accomplishments: Congressional Program Increase		
Congressional Adds Subtotals	7.000	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602270A / <i>Electronic Warfare Technology</i>				Project (Number/Name) 906 / <i>Tactical Electronic Warfare Applied Research</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
906: <i>Tactical Electronic Warfare Applied Research</i>	-	26.683	20.197	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	46.880

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).

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602270A / <i>Electronic Warfare Technology</i>	Project (Number/Name) 906 / <i>Tactical Electronic Warfare Applied Research</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Title: Multi-Intelligence Data Fusion and Targeting</p> <p>Description: This effort investigates, designs and codes advanced automated exploitation and fusion analysis tools, applications, and software services for the creation of improved intelligence products, common information management and information dissemination systems to facilitate collaboration between intelligence and mission command functions. This will provide relevant and timely information in support of command decisions, such as high value identification and targeting in an asymmetric environment.</p>		2.319	-	-
<p>Title: Data Analytics for Situational Awareness</p> <p>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.</p> <p>FY 2019 Plans: Identify relevant tactical receiver data and emerging Internet of Things (IoT) data sources, to include publicly available information, enriching the existing cyber terrain and electromagnetic operations environment; will investigate potential correlation points with non-traditional datasets to identify cyber events; and explore new data analytics, fusion algorithms and semi-automated analytical methods to process and exploit the extended datasets to support cyber situational understanding.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602146A (Network C3I Technology) / Project AN7 (COE - Every Receiver is a Sensor Technology) in FY20 as part of the financial restructuring.</p>		-	2.946	-
<p>Title: Offensive Information Operations Technologies</p> <p>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.</p> <p>FY 2019 Plans: Investigate emerging networks to identify shortfalls in capability to detect, identify and map network nodes; identify future analytic, sensor, and data research needs; and investigate techniques for surgical disruption and unobtrusive operation within native network infrastructures.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement:</p>		7.984	2.470	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602270A / <i>Electronic Warfare Technology</i>	Project (Number/Name) 906 / <i>Tactical Electronic Warfare Applied Research</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
This research effort was realigned to PE 0602146A (Network C3I Technology) / Project AO2 (Stand-In Advanced RF Effects (STARE)) in FY20 as part of the financial restructuring.				
<p>Title: Multispectral Threat Warning and Countermeasures, formerly Multispectral Threat Warning</p> <p>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/Project K16 complements this effort.</p> <p>FY 2019 Plans: Investigate technologies to indiscriminately detect and defeat broad classes of threats; conduct analysis of next-generation detect technologies with focus on machine learning algorithms to enable detection of unrecognized threat features; conduct analysis of advanced defeat technologies focusing on new lasers and laser materials and build a breadboard laser to indiscriminately degrade EO threat sensor performance; investigate RF digital hardware and software techniques that are adaptive to agile RF threats; use modeling and simulation (M&S) to iteratively train machine learning algorithms to perform threat classification and optimize laser countermeasure and RF technique development; and assess performance of technologies (e.g., machine learning, lasers, etc.) and techniques independently and incorporate them into a digital M&S platform.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602148A (Future Vertical Lift Technology) / Project AK2 (Aviation Survivability Technology) in FY20 realignments as part of the financial restructuring.</p>		6.605	6.800	-
<p>Title: Multi-Function Intelligence, Surveillance and Reconnaissance Technologies</p> <p>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.</p> <p>FY 2019 Plans: Research enhanced next generation techniques for distributed sensing and single sensor geolocation to enable detection, and geolocation of advanced threats and inform requirements for future hardware designs; investigate state of the art electronic situational awareness technique susceptibility to adversarial use of next generation RF deception and jamming; investigate cyber hardening of sensor component technology for front-end sensors; investigate a best-of-breed low-cost HF software defined radio for use in an open multifunction ISR platform to be utilized in a hostile cyber environment; will explore trade space of shared multi-function next generation hardware for Radar, SIGINT and EW; perform tradeoff studies to understand the feasibility and impact</p>		8.771	7.246	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602270A / <i>Electronic Warfare Technology</i>	Project (Number/Name) 906 / <i>Tactical Electronic Warfare Applied Research</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
of executing multi-function capabilities from a common RF array with consideration for advancing threat electronic protection capability; and perform laboratory sensing data collections and analysis to address the applicability of a multi-function sensor. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602146A (Network C3I Technology) / Project AN7 COE (Every Receiver is a Sensor Technology) and Project AV3 (Foundational S&T for Network C3I Technology) in FY20 as a result of the financial restructuring.				
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. FY 2019 Plans: Investigate and perform vulnerability analysis on emerging threats (including, but not limited to, tactical communications, ground surveillance radar, and counter-fire radar systems) and mature EW techniques and methods (such as active, reactive, surgical, and protocol based software) with the goals of maximizing EW waveform jamming effectiveness, minimizing transmission time, and reducing jamming power to defeat Army relevant threats. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602146A (Network C3I Technology) / Project AQ2 (EW Techniques Technology) in FY20 as part of the financial restructuring.		1.004	0.500	-
Title: FY 2019 SBIR / STTR Transfer Description: FY 2019 SBIR / STTR Transfer FY 2019 Plans: FY 2019 SBIR / STTR Transfer FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer		-	0.235	-
Accomplishments/Planned Programs Subtotals		26.683	20.197	-
C. Other Program Funding Summary (\$ in Millions) N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602270A / <i>Electronic Warfare Technology</i>	Project (Number/Name) 906 / <i>Tactical Electronic Warfare Applied Research</i>

C. Other Program Funding Summary (\$ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602270A / <i>Electronic Warfare Technology</i>				Project (Number/Name) CYB / <i>Applied Offensive Cyber</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
CYB: <i>Applied Offensive Cyber</i>	-	0.000	5.361	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.361

Note

In Fiscal Year (FY) FY 2020 this Project is realigned to:
 Program Element (PE) 0602146A Network C3I Technology
 * Project AQ3 Network Access and Effects
 PE 0602213A C3I Applied Cyber
 * 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)

Title: Offensive Information Operations Technologies	FY 2018	FY 2019	FY 2020
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.	-	5.165	-
FY 2019 Plans: Investigate utilizing Machine Learning for threat assessment, decision aid, and mission choreography; determine algorithm design needs for recognition and Battle Damage Assessment for the purposes of survey, network topology understanding, and effect			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602270A / <i>Electronic Warfare Technology</i>	Project (Number/Name) CYB / <i>Applied Offensive Cyber</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
assessment; refine CEMA interface definitions to include a mechanism for service/capability discovery to address solidifying mission management across Unified Land Operations platforms. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned in FY20 to PE 0602146A (Network C3I Technology) / Project AQ3 (Network Access and Effects) and PE 0602213A (C3I Applied Cyber) / Project 5CY (Offensive Cyber Operations (OCO) Mirror Technology) in FY20 as part of the financial restructuring.				
Title: FY 2019 SBIR / STTR Transfer Description: FY 2019 SBIR / STTR Transfer FY 2019 Plans: FY 2019 SBIR / STTR Transfer FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer		-	0.196	-
Accomplishments/Planned Programs Subtotals		-	5.361	-
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602303A / <i>Missile Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	52.858	91.647	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	144.505
214: <i>Missile Technology</i>	-	42.858	50.147	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	93.005
G05: <i>MISSILE TECHNOLOGY INITIATIVES (CA)</i>	-	10.000	41.500	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	51.500

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.

In FY18/FY19, 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).

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602303A / <i>Missile Technology</i>
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B. Program Change Summary (\$ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	43.742	50.183	50.468	-	50.468
Current President's Budget	52.858	91.647	0.000	-	0.000
Total Adjustments	9.116	41.464	-50.468	-	-50.468
• Congressional General Reductions	-0.018	-0.036			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	10.000	41.500			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.866	-			
• Adjustments to Budget Years	-	-	-50.468	-	-50.468

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: G05: *MISSILE TECHNOLOGY INITIATIVES (CA)*

Congressional Add: *Composites Research Air Veh Dev & Sust*

Congressional Add: *carbon composite warhead research*

Congressional Add: *additive manufacturing to support optimized long range precision fires*

Congressional Add: *air vehicle development and sustainment*

Congressional Add: *enterprise science and technology prototyping*

Congressional Add Subtotals for Project: G05

Congressional Add Totals for all Projects

	FY 2018	FY 2019
	10.000	-
	-	6.500
	-	10.000
	-	15.000
	-	10.000
Congressional Add Subtotals for Project: G05	10.000	41.500
Congressional Add Totals for all Projects	10.000	41.500

Change Summary Explanation

FY18 Congressional add of \$10 Million

FY19 Congressional add of \$41.5 Million

FY20 PE eliminated due to Science and Technology Financial Restructuring.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602303A / <i>Missile Technology</i>				Project (Number/Name) 214 / <i>Missile Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>214: Missile Technology</i>	-	42.858	50.147	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	93.005

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 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.

FY18/19, major products of this Project transition to PE 0603313A (Missile and Rocket Advanced Technology).

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602303A / <i>Missile Technology</i>	Project (Number/Name) 214 / <i>Missile Technology</i>
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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 2018	FY 2019	FY 2020
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<p>Title: Missile Seeker Technology</p> <p>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.</p> <p>FY 2019 Plans: Will enhance infrared passive precision acquisition and tracking algorithms for true fire-and-forget engagements in global positioning system (GPS)-denied environments; will design, fabricate and evaluate novel mechanical designs utilizing additive manufacturing and new materials for optical sensor applications to enable lower cost infrared seeker optics; perform design analysis to determine man-portable, Air Defense missile seeker requirements and will develop robust seeker modeling and simulation tools to verify design parameter; will design, fabricate and evaluate technologies that support a low cost, strap down, active, electro-optic seeker system for counter unmanned aerial systems (UAS) and counter ground target missiles; design concepts for a multi-band active optical tracker that laser-designates small UAS to increase probability of defeat for seeker based kinetic weapons.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602147A (Long Range Precision Fires Technology) / Project AF9 (Precision and Accuracy Technology) in FY20 as part of the financial restructuring.</p>	4.740	4.648	-
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<p>Title: Missile Guidance, Navigation and Controls Technologies</p> <p>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 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.</p> <p>FY 2019 Plans: Will perform investigation and performance analysis of a multi-sensor survey emplacement system for GPS degraded or denied environments; will fabricate and develop microelectromechanical systems (MEMS) concentric proof mass gyroscope for next generation inertial sensor; will investigate radio frequency (RF) ? based navigation via RF range-finding datalinks as a GPS-independent position aid; will investigate a non-line-of-sight datalink for airborne loitering missiles with air/ground launch capability; will complete evaluation of experimental articles for increased current capacity batteries for long range, small guided missiles; develop magnetoelectric composites, advanced system-on-chip (SoC) integrated circuit electronics parts, and will design processes that reduce the amount of thermal buildup enabling significant improvements in overall material performance and size/</p>	7.773	8.225	-
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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602303A / <i>Missile Technology</i>	Project (Number/Name) 214 / <i>Missile Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>weight reduction; will develop a four dimensional (4-D) printing technology where the printed device properties vary continuously throughout the structure creating a material with varied resistive, graded dielectric, electrical, and thermal management to support RF components; will further develop and evaluate laser source filters for semi-active Laser seeker optics, advanced machine intelligence, and image processing techniques for enhanced target acquisition and engagement.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602147A (Long Range Precision Fires Technology) / Project AF9 (Precision and Accuracy Technology), Project AG1 (Missile Electronics Technology), and Project AG2 Information and Signal Processing Technology in FY20 as part of the financial restructuring.</p>				
<p>Title: Missile Fire Control Systems, Sustainment, Simulations, and Launchers</p> <p>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.</p> <p>FY 2019 Plans: Will further develop DART technologies; will design and develop the full array beginning with RF characterization, digital beam forming evaluations, and algorithm and scenario development; maintain compatibility with 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; will develop amplitude modulated pulse waveforms for next generation radars and seekers in order to improve target resolution and discrimination for challenging air defense scenarios; will develop a generic algorithm and design antennas that allow the use of non-linear conformal antenna structures across any arbitrary array and operating frequency to reduce effective sensor size, weight, and power (SWAP); will investigate and design an open/modular architecture for future missile health monitoring units (HMUs) that address shortfalls/limitations in existing fielded capability and accommodate lower cost/quicker expansion of missile HMU capability; will develop and demonstrate subscale novel conductive materials capable of supplementing battery life, and also have the ability to be electrically ignited to increase lethality; will develop modeling & simulation capabilities of hypersonic vehicles in low density flows at high altitude and develop a supersonic inlet code tailor made for air breathing missile propulsion enabling rapid design decisions.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602150A (Air and Missile Defense Technology) / Project AD5 (Next Generation Fires Radar Technology) and AD7 (Missile Fire Control Sensors Technology) in FY20 as part of the financial restructuring.</p>		7.409	6.851	-
<p>Title: Missile Propulsion, Structures, Lethality, and Aerodynamic Technology</p> <p>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</p>		5.749	7.142	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602303A / <i>Missile Technology</i>	Project (Number/Name) 214 / <i>Missile Technology</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
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<p>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)..</p>			
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FY 2019 Plans:

Will investigate and characterize enabling energetic technologies for applications to missile propellants; will perform final characterization and evaluation of next generation minimum smoke propellants that improve missile performance via reduced burning rate sensitivity; will further develop low-cost integral rocket ramjet technology for extended range deep strike capability; will demonstrate techniques for reducing rocket motor light emissions sufficient to defeat adversary's launch detection methods for increased survivability; will develop advanced hardware and subsystem technology to enable mission flexibility via dual pulse motor for future small guided missiles from rotary wing and UAS platforms; will design and develop high performance variable thrust and impulse technologies that can efficiently operate over extended duty cycles, altitudes, and tactical temperatures providing enhanced capabilities against highly maneuverable targets; will design and analyze of high temperature materials supporting high flight speed missiles and dynamic end game scenarios; will further develop modeling tools, additive manufacturing processes, and materials to optimize performance and reducing weight and cost of missile structures; will develop and perform proof of principle testing of novel warhead technologies for providing overwhelming catastrophic effects against current and emerging threat vehicles to include Main Battle Tanks (MBT); will design and develop warhead subsystem analysis of advanced shaped charge, explosively formed penetrators, and fragmentation technologies to enhance warfighter lethality and provide overmatch; will develop lethality simulations utilized for trade space and predicting the probability of kill for multiple-purpose warhead configurations against multiple target classes.

FY 2019 to FY 2020 Increase/Decrease Statement:

This research effort was realigned to PE 06020147A (Long Range Precision Fires Technology) / Project AF3 (Extended Range Propulsion Technology) , Project AF5 (Simulation and Aerostructures Technology), Project AF6 (Structures Technology), and Project AF7 (Warhead Integration Technology) in FY20 as part of the financial restructuring.

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.

FY 2019 Plans:

Will mature modular missile technology components and open system architecture into subsystems and verify subsystem performance for the drop/glide variant in bench-level and laboratory environments.

FY 2019 to FY 2020 Increase/Decrease Statement:

<p><i>Title:</i> Multi-Role Missile Technology</p> <p><i>Description:</i> 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.</p> <p><i>FY 2019 Plans:</i></p> <p>Will mature modular missile technology components and open system architecture into subsystems and verify subsystem performance for the drop/glide variant in bench-level and laboratory environments.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i></p>	3.186	1.728	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602303A / <i>Missile Technology</i>	Project (Number/Name) 214 / <i>Missile Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
This research effort was realigned to PE 06020148A (Future Vertical Lift Technology) / Project AK4 (Multi-Role Small Guided Missile Technology) in FY20 as part of the financial restructuring.				
<p>Title: Air Defense Missile Technologies (formerly Counter Unmanned Aerial Systems and Counter Cruise Missile)</p> <p>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.</p> <p>FY 2019 Plans: Will further the design of critical air defense interceptor technologies and components; will mature guidance electronics units for the Ballistic and Control Test Vehicle evaluations and will conduct Ballistic Test Vehicle Flight Testing; mature the control actuation system and demonstrate it in laboratory dynamic flight test simulation apparatus; will continue to develop software algorithms to fuse data from radar, electro-optical/Infrared, and acoustic sensors enabling a common operating picture of threat unmanned aerial systems.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort will realign to PE 06020150A (Air and Missile Defense Technology) / Project AD3 (Maneuver Air Defense Technology) in FY20 as part of the financial restructuring.</p>		5.368	8.300	-
<p>Title: Affordable Precision Missile Enabling Technology</p> <p>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.</p> <p>FY 2019 Plans: Will perform trade studies, develop concepts, generate designs, and explore technologies for affordable discrimination of extended range precision missiles for indirect fires capabilities.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort realigns to PE 06020147A (Long Range Precision Fires Technology) / Project AF8 (Affordable Extended Range Precision Technology) in FY20 as part of the financial restructuring.</p>		3.787	2.223	-
<p>Title: Long Range Fires Enabling Technology</p> <p>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.</p> <p>FY 2019 Plans:</p>		4.846	6.552	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602303A / <i>Missile Technology</i>	Project (Number/Name) 214 / <i>Missile Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Will continue to develop and evaluate emerging navigation technologies and techniques; will design navigation system integration architectures and algorithms capable of integration emerging navigation technologies into an enhanced precision navigation solution; will design propulsion systems, including alternate propulsion cycles, to increase the range of the system; will design lightweight airframe structures to increase range of the system; will develop technologies that contribute to missile survivability in a contested environment. Will develop and evaluate a multi-mode seeker to enable precision guidance in GPS denied or degraded environments; radio frequency sensor to guide to radiating targets, infrared sensor with advanced image processing to enable target classification and aim point selection for both land and maritime targets; miniaturization of sensor and guidance components; investigate data link technologies to provide in-flight target updates.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort realigns to PE 06020147A (Long Range Precision Fires Technology) / Project AE7 (Land-Based Anti-Ship Missile (LBASM) Technology) in FY20 as part of the financial restructuring.</p>				
<p>Title: Cooperative Engagement Lethality Technology</p> <p>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.</p> <p>FY 2019 Plans: Will develop optimized missile design with multi-effects lethal mechanism, man-in-the-loop and loiter capability for situational awareness, targeting, and lethal effects against hard and soft targets. Will develop application-based fire control unit software hosted on a commercial end user device, extended range datalink enablers, and GPS/comms denied navigation/targeting technologies.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort realigns to PE 06020147A (Long Range Precision Fires Technology) / Project AH2 (Single Multi-mission Attack Missile (SMAM) Technol), and Project AG9 (Multiple Simul Engagement Technologies (MSET) Tech) in FY20 as part of the financial restructuring.</p>		-	3.327	-
<p>Title: FY 2019 SBIR / STTR Transfer</p> <p>Description: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 Plans: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement:</p>		-	1.151	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602303A / <i>Missile Technology</i>	Project (Number/Name) 214 / <i>Missile Technology</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
FY 2019 SBIR / STTR Transfer			
Accomplishments/Planned Programs Subtotals	42.858	50.147	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602303A / <i>Missile Technology</i>				Project (Number/Name) G05 / <i>MISSILE TECHNOLOGY INITIATIVES (CA)</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
G05: <i>MISSILE TECHNOLOGY INITIATIVES (CA)</i>	-	10.000	41.500	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	51.500

Note

Congressional Program increase for Fiscal Year (FY) 2018 and FY19.

A. Mission Description and Budget Item Justification

This is a Congressional Interest Item.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019
Congressional Add: Composites Research Air Veh Dev & Sust	10.000	-
FY 2018 Accomplishments: Composites Research Air Veh Dev & Sust		
Congressional Add: carbon composite warhead research	-	6.500
FY 2019 Plans: carbon composite warhead research		
Congressional Add: additive manufacturing to support optimized long range precision fires	-	10.000
FY 2019 Plans: additive manufacturing to support optimized long range precision fires		
Congressional Add: air vehicle development and sustainment	-	15.000
FY 2019 Plans: air vehicle development and sustainment		
Congressional Add: enterprise science and technology prototyping	-	10.000
FY 2019 Plans: enterprise science and technology prototyping		
Congressional Adds Subtotals	10.000	41.500

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602303A / <i>Missile Technology</i>	Project (Number/Name) G05 / <i>MISSILE TECHNOLOGY INITIATIVES (CA)</i>

E. Performance Metrics N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602307A / <i>Advanced Weapons Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	36.959	44.468	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	81.427
042: <i>High Energy Laser Technology</i>	-	21.959	29.468	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	51.427
NA5: <i>Advanced Weapons Components (CA)</i>	-	15.000	15.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	30.000

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.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602307A / <i>Advanced Weapons Technology</i>
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B. Program Change Summary (\$ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	22.785	29.502	24.457	-	24.457
Current President's Budget	36.959	44.468	0.000	-	0.000
Total Adjustments	14.174	14.966	-24.457	-	-24.457
• Congressional General Reductions	-0.017	-0.034			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	15.000	15.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.809	-			
• Adjustments to Budget Years	-	-	-24.457	-	-24.457

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: NA5: *Advanced Weapons Components (CA)*

Congressional Add: *High Energy Laser Development for ATVs*

Congressional Add: *Army Aerophysics Research*

Congressional Add: *High energy laser technology*

Congressional Add: *COE in high energy and laser and optical technology*

Congressional Add Subtotals for Project: NA5

Congressional Add Totals for all Projects

	FY 2018	FY 2019
	10.000	-
	5.000	-
	-	10.000
	-	5.000
Congressional Add Subtotals for Project: NA5	15.000	15.000
Congressional Add Totals for all Projects	15.000	15.000

Change Summary Explanation

FY18 Congressional add of \$15 Million

FY19 Congressional add of \$15 Million

FY20 PE eliminated due to Science & Technology Financial Restructuring.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602307A / <i>Advanced Weapons Technology</i>				Project (Number/Name) 042 / <i>High Energy Laser Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>042: High Energy Laser Technology</i>	-	21.959	29.468	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	51.427

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 Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Solid State Laser Effects	FY 2018	FY 2019	FY 2020
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.	3.538	4.051	-
FY 2019 Plans:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602307A / <i>Advanced Weapons Technology</i>	Project (Number/Name) 042 / <i>High Energy Laser Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Will complete vulnerability modules and lethality database inputs for UAS Groups 1, 2, and 3. Will continue development of lethality database input for rocket, artillery, and mortar (RAM) threats supporting HEL Tactical Vehicle Demonstrator (TVD). Will begin investigating lethal/aimpoint on manned fixed- and rotary-wing aircraft.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort will realign to PE 0602150A (Air and Missile Defense Technology) / Project AC9 (High Energy Laser Tactical Vehicle Demonstrator Te), Project AD2 (High Energy Laser (HEL) Enabling and Support Techn), and Project AD9 (Close Combat High Energy Laser Technology) in FY20 as part of the financial restructuring.</p>				
<p>Title: Advanced Beam Control Component Development</p> <p>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 High Energy Laser (HEL) Joint Technology Office (JTO) and other Services.</p> <p>FY 2019 Plans: Will complete Critical Design Review (CDR) for the BCS for the High Energy Laser Tactical Vehicle Demonstrator (HEL TVD). Will validate performance of a state-of-the-art adaptive optics (AO) subsystem on a test range using the Mobile Beam Control System Integration Laboratory (MBC SIL), a key knowledge point for HEL TVD development.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort will realign to PE 0602150A (Air and Missile Defense Technology) / Project AC9 (High Energy Laser Tactical Vehicle Demonstrator Te), Project AD2 (High Energy Laser (HEL) Enabling and Support Techn), and Project AD9 (Close Combat High Energy Laser Technology) in FY20 as part of the financial restructuring.</p>		7.084	17.419	-
<p>Title: High Efficiency Laser Development</p> <p>Description: This effort develops component technologies that increase Solid State Laser (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 High Energy Laser (HEL) Joint Technology Office (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, Project L96.</p> <p>FY 2019 Plans: Will complete 100kW laser subsystem build in support of the High Energy Laser Tactical Vehicle Demonstrator (HEL TVD) effort.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement:</p>		9.916	5.951	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602307A / <i>Advanced Weapons Technology</i>	Project (Number/Name) 042 / <i>High Energy Laser Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
This research effort will realign to PE 0602150A (Air and Missile Defense Technology) / Project AC9 (High Energy Laser Tactical Vehicle Demonstrator Te), Project AD2 (High Energy Laser (HEL) Enabling and Support Techn), and Project AD9 (Close Combat High Energy Laser Technology) in FY20 as part of the financial restructuring.				
<p>Title: HEL Research and Development and Concepts Analysis Laboratories</p> <p>Description: This effort focuses on developing in-house expertise through Solid State Laser (SSL) assessments and starting in Fiscal Year (FY) 2015, other USASMDC/ARSTRAT technical core competencies, including air and missile defense, responsive space, and small satellites.</p> <p>FY 2019 Plans: Will complete analysis of laboratory level experiments to validate ETS performance against baseline requirements. Will complete collecting field data to support model verification. Will develop initial algorithms for advance adaptive optics.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort will realign to PE 0602150A (Air and Missile Defense Technology) / Project AC9 (High Energy Laser Tactical Vehicle Demonstrator Te), Project AD2 (High Energy Laser (HEL) Enabling and Support Techn), and Project AD9 (Close Combat High Energy Laser Technology) in FY20 as part of the financial restructuring.</p>		1.421	1.033	-
<p>Title: FY 2019 SBIR / STTR Transfer</p> <p>Description: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 Plans: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer</p>		-	1.014	-
Accomplishments/Planned Programs Subtotals		21.959	29.468	-
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602307A / <i>Advanced Weapons Technology</i>	Project (Number/Name) 042 / <i>High Energy Laser Technology</i>

<u>E. Performance Metrics</u> N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602307A / <i>Advanced Weapons Technology</i>				Project (Number/Name) NA5 / <i>Advanced Weapons Components (CA)</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
NA5: <i>Advanced Weapons Components (CA)</i>	-	15.000	15.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	30.000

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 2018	FY 2019
Congressional Add: High Energy Laser Development for ATVs	10.000	-
FY 2018 Accomplishments: High Energy Laser Development for ATVs		
Congressional Add: Army Aerophysics Research	5.000	-
FY 2018 Accomplishments: Army Aerophysics Research		
Congressional Add: High energy laser technology	-	10.000
FY 2019 Plans: High energy laser technology		
Congressional Add: COE in high energy and laser and optical technology	-	5.000
FY 2019 Plans: COE in high energy and laser and optical technology		
Congressional Adds Subtotals	15.000	15.000

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602308A / <i>Advanced Concepts and Simulation</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	27.662	28.470	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	56.132
C90: <i>Advanced Distributed Simulation</i>	-	22.451	26.841	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	49.292
D02: <i>Modeling & Simulation For Training And Design</i>	-	5.211	1.629	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	6.840

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).

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602308A / <i>Advanced Concepts and Simulation</i>
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B. Program Change Summary (\$ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	28.650	28.500	28.765	-	28.765
Current President's Budget	27.662	28.470	0.000	-	0.000
Total Adjustments	-0.988	-0.030	-28.765	-	-28.765
• Congressional General Reductions	-0.020	-0.030			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.968	-			
• Adjustments to Budget Years	-	-	-28.765	-	-28.765

Change Summary Explanation

FY20 decrease related to Science & Technology financial restructuring.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602308A / <i>Advanced Concepts and Simulation</i>				Project (Number/Name) C90 / <i>Advanced Distributed Simulation</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
C90: <i>Advanced Distributed Simulation</i>	-	22.451	26.841	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	49.292

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 2018	FY 2019	FY 2020
Title: Live and Medical Training Technologies	6.500	5.800	-
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.			
FY 2019 Plans: Investigate components such as artificial intelligence algorithms to aid in target recognition, next generation magnetometers, high resolution simulated three dimension terrain and weapon orientation to enhance live training technology research; research in live training technologies will support the Army's capability need to provide live simulations that accurately replicate and realistically represent the effects of current weapons systems during force-on-force and force-on-target training; design and develop capabilities to improve the accuracy and fidelity of medical simulations for training; investigate and characterize gross			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602308A / <i>Advanced Concepts and Simulation</i>	Project (Number/Name) C90 / <i>Advanced Distributed Simulation</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
and subtle tissue behaviors necessary for higher levels of medical understanding; investigate and develop medical simulation environments that accurately represent the operational environment both inside and outside of the body. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project BC7 (Training Technology (Other than STE)) in FY20 as part of financial restructuring.				
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. FY 2019 Plans: Extend models for individual learners, instructional management, and Army task domains to increase the complexity of adaptive training for individuals to enable future adaptive training; validate a base authoring concept for individual adaptive training; expand concepts for authoring tools, team modeling, team instruction, and Army team domains to support development of team (unit level) tutoring systems; mature training strategies for autonomous software systems; develop recommended systems to reinforce experiential learning of autonomous systems via machine learning techniques. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project BC3 (Soldier Decision Making & Comms Performance Tech), Project BC7 (Training Technology (Other than STE), and PE 0602143A (Soldier Lethality Technology) / Project BE8 Synthetic Training Environment (STE) Technology) in FY20 as part of the financial restructuring.		5.200	2.800	-
Title: Soldier System Architecture Description: Research and develop simulation architecture to represent the Soldier as a System considering physiological effects, cognitive load, and Soldier culture in the context of Soldier-materiel interactions supporting training effectiveness, experimentation, and materiel development. The architecture will advance computational strategies to enable the integration and interaction of new and existing Soldier models into a seamless Soldier as a System simulation.		1.275	-	-
Title: Training Effectiveness Research 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		1.276	1.333	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602308A / <i>Advanced Concepts and Simulation</i>	Project (Number/Name) C90 / <i>Advanced Distributed Simulation</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>legacy systems that require training of primarily procedural tasks. This is compounded by parallel increases in autonomy and responsibility at lower echelons.</p> <p>FY 2019 Plans: Investigate methods and techniques to optimize individual and team training outcomes (cognitive, physiological, physical) for autonomous systems; extend development of techniques to improve recommender systems that will maximize training for teams using complex, adaptive, and intelligent autonomous systems.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This effort ends in FY19.</p>				
<p>Title: Rapid Soldier Capability Enhancement - Training</p> <p>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.</p> <p>FY 2019 Plans: Explore augmentation technologies with potentially broad applications, to include adaptive training applications to increase Soldier performance and reduce time-to-proficiency in mounted and dismounted Soldier tasks; investigate novel approaches for integrating advanced metrics of factors related to individual variability into adaptive training technologies to enable augmentation techniques in complex training applications.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project BC3 (Soldier Decision Making & Comms Performance Tech), Project BC7 (Training Technology (Other than STE), and PE 0602143A (Soldier Lethality Technology) / Project BE8 Synthetic Training Environment (STE) Technology) in FY20 as part of the financial restructuring.</p>		2.000	2.100	-
<p>Title: Synthetic Natural Environments</p> <p>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. This effort is coordinated with and complements PE 0603015A/Project S28.</p> <p>FY 2019 Plans: Research in synthetic natural environments supports the Army capability need to rapidly and accurately collect, develop, digitize, store, and access detailed terrain information from a single correlated terrain database that is easily scalable from soldier</p>		6.200	2.200	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602308A / <i>Advanced Concepts and Simulation</i>	Project (Number/Name) C90 / <i>Advanced Distributed Simulation</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>level to global level views of the world. This is part of the Army future synthetic training environment and One World Terrain representation; develop dynamic terrain /updates that dynamically change the synthetic environment based on simulated and real world events; investigate data exploitation and advanced rendering techniques for geospatial data at runtime to produce realistic human interactions; research advanced synthetic generation techniques as to the scalability required for detail and quantity needed for complete data/content coverage of the globe.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project BE8 (Synthetic Training Environment (STE) Technology) in FY20 as part of the financial restructuring.</p>				
<p>Title: Mixed Reality Research</p> <p>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.</p> <p>FY 2019 Plans: Examine how interfaces for virtual training systems affect user interactions with those systems and thereby impact training and performance outcomes; examine how different interfaces for virtual training systems can be used to more seamlessly integrate live and virtual training to improve training transfer from virtual to live; investigate and design the synthetic framework, architecture, and technologies to enable a manned/unmanned teaming training and rehearsal simulation environment.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project BC3 (Soldier Decision Making & Comms Performance Tech), Project BC7 (Training Technology (Other than STE), and PE 0602143A (Soldier Lethality Technology) / Project BE8 Synthetic Training Environment (STE) Technology) in FY20 as part of the financial restructuring.</p>		-	4.000	-
<p>Title: Cyber for Training Simulations</p> <p>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.</p> <p>FY 2019 Plans:</p>		-	2.750	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602308A / <i>Advanced Concepts and Simulation</i>	Project (Number/Name) C90 / <i>Advanced Distributed Simulation</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>Investigate analytical capabilities and methodologies for generating models from empirical data and social and psychological theory to describe CEMA-related human attributes (e.g., intent, posture, and capability); and design initial simulation environment integrating new human models with existing and developing CEMA representations.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project BC3 (Soldier Decision Making & Comms Performance Tech), Project BC7 (Training Technology (Other than STE), and PE 0602143A (Soldier Lethality Technology) / Project BE8 Synthetic Training Environment (STE) Technology) in FY20 as part of the financial restructuring.</p>			
<p>Title: Artificial Intelligence</p> <p>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.</p> <p>FY 2019 Plans: Investigate capabilities for data mining to better predict individualized degradation in task performance after completion of training; and design initial capabilities for identifying appropriate training resources to mitigate this degradation using individualized intelligent training technologies.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project BC3 (Soldier Decision Making & Comms Performance Tech), Project BC7 (Training Technology (Other than STE), PE 0602143A (Soldier Lethality Technology) / Project BE8 Synthetic Training Environment (STE) Technology), and PE 0602145A (Next generation Combat Vehicle Technology) / Project BF6 (Crew Augmentation and Optimization Tech) in FY20 as part of the financial restructuring.</p>	-	1.500	-
<p>Title: Synthetic Training Environment Acceleration</p> <p>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 ASCC can train in the most appropriate domain - live, virtual, constructive, and gaming, or in all four simultaneously.</p> <p>FY 2019 Plans: Mature artificial intelligence (AI) representation of simulated forces to model relevant aspects of the Multi Domain Operations (MDO), increase simulated entity scalability and increase concurrent role-players to enable synthetic collective training; investigate the automated generation of high fidelity synthetic natural environment data in support of the Army's future synthetic training environment global terrain requirement; determine techniques to automate the attribution of terrain, procedurally extract building extents and apply surface features utilizing point cloud, texture, crowd-sourced and other emerging sources of data; design and</p>	-	3.500	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602308A / <i>Advanced Concepts and Simulation</i>	Project (Number/Name) C90 / <i>Advanced Distributed Simulation</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
develop terrain resolution algorithms which encompass the ability to embed Human Terrain (cultural attributes, infrastructure, social media) in the synthetic environment. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project BE8 (Synthetic Training Environment (STE) Technology) in FY20 as part of the financial restructuring.				
Title: FY 2019 SBIR / STTR Transfer Description: FY 2019 SBIR / STTR Transfer FY 2019 Plans: FY 2019 SBIR / STTR Transfer FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer		-	0.858	-
Accomplishments/Planned Programs Subtotals		22.451	26.841	-
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602308A / <i>Advanced Concepts and Simulation</i>				Project (Number/Name) D02 / <i>Modeling & Simulation For Training And Design</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>D02: Modeling & Simulation For Training And Design</i>	-	5.211	1.629	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	6.840

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)

Title: Immersive Technology Environments	FY 2018	FY 2019	FY 2020
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.	2.606	1.052	-
FY 2019 Plans:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602308A / <i>Advanced Concepts and Simulation</i>	Project (Number/Name) D02 / <i>Modeling & Simulation For Training And Design</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
Utilize brain imaging studies, such as magnetic resonance imaging (MRI), to identify specific regions and networks of the brain affected by virtual reality, related to empathy and decision making which will help reveal neurological mechanisms of how virtual reality can aid military personnel in making better decisions. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project BC7 (Training Technology (Other than STE)), and Project BE8 Synthetic Training Environment (STE) Technology) in FY20 as a result of the S&T financial restructuring.				
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. FY 2019 Plans: Conduct research to enable Soldiers to train in simulated environments using applied research to provide technology options for development and transition. These technologies derived from this research will address the complex operational environment elements and multi-domain interactions in order to provide accelerated, adaptable, flexible, and sustained unit readiness for the full range of Army missions. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project BC7 (Training Technology (Other than STE)), and Project BE8 Synthetic Training Environment (STE) Technology) in FY20 as a result of the S&T financial restructuring.		2.605	0.525	-
Title: FY 2019 SBIR / STTR Transfer Description: FY 2019 SBIR / STTR Transfer FY 2019 Plans: FY 2019 SBIR / STTR Transfer FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer		-	0.052	-
Accomplishments/Planned Programs Subtotals		5.211	1.629	-
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602308A / <i>Advanced Concepts and Simulation</i>	Project (Number/Name) D02 / <i>Modeling & Simulation For Training And Design</i>

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602601A / <i>Combat Vehicle and Automotive Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	78.759	104.404	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	183.163
C05: <i>Armor Applied Research</i>	-	18.999	21.474	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	40.473
H77: <i>National Automotive Center</i>	-	17.347	12.082	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	29.429
H91: <i>Ground Vehicle Technology</i>	-	32.413	36.848	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	69.261
T26: <i>Ground Vehicle Technologies (CA)</i>	-	10.000	34.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	44.000

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.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602601A / <i>Combat Vehicle and Automotive Technology</i>
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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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	67.232	70.450	69.169	-	69.169
Current President's Budget	78.759	104.404	0.000	-	0.000
Total Adjustments	11.527	33.954	-69.169	-	-69.169
• Congressional General Reductions	-0.028	-0.046			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	10.000	34.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	2.882	-			
• SBIR/STTR Transfer	-1.327	-			
• Adjustments to Budget Years	-	-	-69.169	-	-69.169

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: T26: *Ground Vehicle Technologies (CA)*

Congressional Add: *Program Increase*

	FY 2018	FY 2019
	10.000	34.000
Congressional Add Subtotals for Project: T26	10.000	34.000
Congressional Add Totals for all Projects	10.000	34.000

Change Summary Explanation

FY18 increase related to Congressional add of \$10 Million
 FY19 increase related to Congressional add of \$34 Million
 FY20 increase related to Science and Technology financial restructuring

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / <i>Combat Vehicle and Automotive Technology</i>	Project (Number/Name) C05 / <i>Armor Applied Research</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>C05: Armor Applied Research</i>	-	18.999	21.474	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	40.473

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 2018	FY 2019	FY 2020
<p>Title: Advanced Armor Development:</p> <p>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.</p> <p>FY 2019 Plans: Will mature design of adaptive armor subsystem for system integration; will complete experiments on system attachments to validate component integration; will use the integration experiment results to identify and design the desired attachment approach for follow-on integration of those technologies; will verify performance of subsystem integration design for adaptive armor</p>	10.417	9.826	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / <i>Combat Vehicle and Automotive Technology</i>	Project (Number/Name) C05 / <i>Armor Applied Research</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
technologies through experimentation and finite element modeling; will begin design and development of hybrid multi-threat armor subsystem.				
<p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort realigns to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BG6 (Advanced Concepts for Active Defense Technology) in FY20 as part of the financial restructure.</p> <p>Title: Blast Mitigation:</p> <p>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 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.</p> <p>FY 2019 Plans: Will develop and document best practices (multi-material, cost-conscious, lightweight design) for optimization of structural subsystem technologies that will provide platform ballistic protection. Will complete individual component performance testing of seats, restraints, flooring, and structures.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This program ends in FY19..</p>		2.324	2.441	-
<p>Title: Improved Situational Awareness for Ground Platforms</p> <p>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.</p> <p>FY 2019 Plans: Will mature increased local SA components in DVE using scalable low cost Local Situational Awareness (LSA) sensors and a digital video architecture system. Will investigate advanced vehicle crew stations with scalable Warfighter-Machine Interface (WMI), augmented reality and crew aids. Will conduct experiments to validate decreased visual latency, increased SA, increased target detection, and increased operational tempo in DVE.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement:</p>		5.001	4.499	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / <i>Combat Vehicle and Automotive Technology</i>	Project (Number/Name) C05 / <i>Armor Applied Research</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
This program ends in FY19.				
Title: Vision Protection Description: This effort investigates and develops protection materials, concepts, and devices to protect vehicle occupants' eyes, vehicle cameras and electro-optical fire control systems against emerging laser threats. This effort also evaluates methods to apply the advanced protection materials, concepts, and devices onto vehicle cameras and electro-optical systems to prevent lasers from destroying sighting systems, disabling cameras that provide situational awareness, and damaging or disorienting Warfighter vision.		1.257	-	-
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. FY 2019 Plans: Will investigate concepts for protection of autonomous systems in forecasted operational environments. Will identify technologies that address projected threats and hazards. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort realigns to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BH9 (Protection for Autonomous Systems Tech) in FY20 as part of the financial restructuring.		-	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. FY 2019 Plans: Will investigate and analyze future hard-kill and soft-kill active defense concepts for use with combat vehicles. Will investigate and design modular components according to architecture and interface requirements. Will develop and assess advanced soft-kill technologies that will defeat higher-level and emerging threats. FY 2019 to FY 2020 Increase/Decrease Statement:		-	1.762	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / <i>Combat Vehicle and Automotive Technology</i>	Project (Number/Name) C05 / <i>Armor Applied Research</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort realigns to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BG6 (Advanced Concepts for Active Defense Technology) in FY20 as part of the financial restructuring.			
Title: FY 2019 SBIR / STTR Transfer	-	0.562	-
Description: FY 2019 SBIR / STTR Transfer			
FY 2019 Plans: FY 2019 SBIR / STTR Transfer			
FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer			
Accomplishments/Planned Programs Subtotals	18.999	21.474	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602601A / <i>Combat Vehicle and Automotive Technology</i>				Project (Number/Name) H77 / <i>National Automotive Center</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H77: <i>National Automotive Center</i>	-	17.347	12.082	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	29.429

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)

Title: Power, Energy and Mobility:	FY 2018	FY 2019	FY 2020
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.	4.076	4.224	-
FY 2019 Plans:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / <i>Combat Vehicle and Automotive Technology</i>	Project (Number/Name) H77 / <i>National Automotive Center</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Will continue to leverage commercial and academic investments into dual use power, energy, and mobility technologies. Will investigate advances in battery design and safety. Will conduct fuel-cell experimentations, in order to mature component designs, and investigate alternative base fuels. Will research into electrification of parasitic powertrain and vehicle loads that promise weight savings in addition to more efficient use of onboard power. Will identify feasible material options to reduce weight and/or increase structural integrity which would improve mobility in areas such as: aluminum, composites, joining technologies, and design optimization.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort realigns to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BJ3 (Hydrogen Based Combat System Technology) and Project BI9 (Vehicle System Security Technology) as part of the financial restructuring</p>				
<p>Title: Dual Use Technologies:</p> <p>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.</p> <p>FY 2019 Plans: Will research ground vehicle technologies with both military and commercial applications. Will conduct experiments with innovative human machine interfaces, advanced vehicle networking, and vehicle automation technologies. Will focus on vehicle security engineering best practices that prevent detriment to crew and vehicles from cyber-attacks. Will research of autonomy systems on coalition international vehicles. Will further the advancement of tactics, training, and procedures (TTPs) for inclusion of autonomous systems and studies on vehicle networking and cyber security. Will mature concepts to increase logistics fleet affordability and reduce logistics footprint through autonomy.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort realigns to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BJ3 (Hydrogen Based Combat System Technology) and Project BI9 (Vehicle System Security Technology) in FY20 as part of the financial restructuring.</p>		13.271	7.497	-
<p>Title: FY 2019 SBIR / STTR Transfer</p> <p>Description: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 Plans:</p>		-	0.361	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / <i>Combat Vehicle and Automotive Technology</i>	Project (Number/Name) H77 / <i>National Automotive Center</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
FY 2019 SBIR / STTR Transfer				
<i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> FY 2019 SBIR / STTR Transfer				
Accomplishments/Planned Programs Subtotals		17.347	12.082	-
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / <i>Combat Vehicle and Automotive Technology</i>	Project (Number/Name) H91 / <i>Ground Vehicle Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H91: <i>Ground Vehicle Technology</i>	-	32.413	36.848	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	69.261

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 2018	FY 2019	FY 2020
Title: Propulsion and Thermal Systems:	7.039	5.909	-
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.			
FY 2019 Plans:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / <i>Combat Vehicle and Automotive Technology</i>	Project (Number/Name) H91 / <i>Ground Vehicle Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Will conduct experiments on advanced heat exchanger, efficient fan, and waste heat recovery system in the advanced thermal management system. Will validate advanced thermal management system design. Will improve the component and system design based on test results. Will complete subsystem testing of high power density engine and transmission.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort realigns to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BH5 (Platform Electrification & Mobility Technology) in FY20 as part of the financial restructuring.</p>				
<p>Title: Power Management Technologies:</p> <p>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, 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.</p> <p>FY 2019 Plans: Will validate power architecture control software functionality in order to confirm power quality, prioritization and optimization algorithms that maximize available power on the vehicle. Will validate environmental, EMI, reliability performance, and other testing of high operating temperature vehicle power architecture system Silicon Carbide components and software to ensure readiness for future combat vehicle testing.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort realigns to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BH5 (Platform Electrification & Mobility Technology) in FY20 as part of the financial restructuring.</p>		3.258	2.586	-
<p>Title: Power Electronics, Hybrid Electric and Onboard Vehicle Power (OBVP) Components:</p> <p>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.</p> <p>FY 2019 Plans:</p>		1.323	0.233	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / <i>Combat Vehicle and Automotive Technology</i>	Project (Number/Name) H91 / <i>Ground Vehicle Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Will complete analysis and system design optimization on an advanced combat vehicle propulsion system. Will evaluate the increase in onboard vehicle power availability and fuel efficiency with no negative impact to vehicle mobility.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort realigns to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BH5 (Platform Electrification & Mobility Technology) in FY20 as part of the financial restructuring.</p>				
<p>Title: Advanced Non-Primary Power Systems:</p> <p>Description: This effort researches, investigates, conducts experiments and validates Auxiliary Power Units (APUs) technologies such as modular/scalable engine based APUs, fuel cell reformer systems to convert JP 8 to hydrogen, sulfur tolerant JP 8 fuel cell APUs and novel engine based APUs for military ground vehicle and unmanned ground systems. This effort also determines inputs for APU interface control documents, as well as investigates solutions for reducing APU acoustic signature for silent operation during mounted surveillance missions. This effort investigates the use of small engines and JP 8 fuel cell systems for use as prime power solutions for unmanned ground systems.</p>		1.900	-	-
<p>Title: Elastomer Improvement Program:</p> <p>Description: This effort researches, formulates and tests new elastomer (rubber) compounds for vehicle track systems to increase track system durability, reduce track system failures and reduce Operations & Sustainment (O&S) costs related to premature track system failures.</p>		1.236	-	-
<p>Title: Intelligent Systems Technology Research:</p> <p>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.</p> <p>FY 2019 Plans: Will develop advanced vehicle behaviors to transition to autonomy-enabling kits for tactical wheeled vehicles in leader-follower convoy operations. Will continue to develop and design common user interfaces and open architecture design. Will continue to research automation software and algorithms, increased robotic reliability and autonomous testing methodologies and procedures. Will continue to advance capabilities to enable operations in increasingly challenging environments like off-road terrain and reduced communication areas.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement:</p>		10.490	9.919	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / <i>Combat Vehicle and Automotive Technology</i>	Project (Number/Name) H91 / <i>Ground Vehicle Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
This research effort realigns to PE 0602145A (Next Generation Combat Vehicle Technology) / BF1 (Autonomous Ground Resupply Tech) in FY20 as part of the financial restructuring.				
<p>Title: Energy Storage:</p> <p>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.</p> <p>FY 2019 Plans: Will conduct durability and performance experimentation at the battery pack level for advanced Li-ion chemistries to validate improved energy density, starting, lighting, propulsion system ignition, silent watch, reliability, battery safety management, for military vehicles.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort realigns to PE 0602145A (Next Generation Combat Vehicle Technology) / BH5 (Platform Electrification and Mobility Tech) in FY20 as part of the financial restructuring.</p>		3.093	2.451	-
<p>Title: Anti-Tamper</p> <p>Description: This effort investigates and develops mature anti tamper methodologies and technologies in combat and tactical vehicles. Technologies such as controllers and tactical information systems for autonomous appliques, active protection systems, and Command, Control, Communications, Computers & Intelligence (C4I), will be designed for enhanced protection against current and evolving threats. This includes: enhancing and defending technologies used to secure data in vehicle systems; defending against the threat of unwanted behavioral changes in multi agent systems; the prevention of unauthorized control of, or denying service to a targeted platform; reverse engineering and conducting vehicle digital forensics; and responding to active attacks that have penetrated anti tamper defenses in a platform.</p>		4.074	-	-
<p>Title: Crew Station</p> <p>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.</p>		-	4.690	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / <i>Combat Vehicle and Automotive Technology</i>	Project (Number/Name) H91 / <i>Ground Vehicle Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p><i>FY 2019 Plans:</i> Will conduct experiments to provide data to improve early warning detections, reduce response times and shorten task durations for future crewstation programs. Will investigate crew size reduction to determine if the same overall performance can be produced by performing simulations to provide data, reports and analysis to the future fighting vehicles.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort realigns to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BF6 (Crew Augmentation and Optimization Technology) in FY20 as part of the financial restructuring.</p>				
<p><i>Title:</i> Unmanned Ground Systems Research</p> <p><i>Description:</i> 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.</p> <p><i>FY 2019 Plans:</i> Will investigate vehicle behaviors to enable teamed robotic and autonomous systems to support specific capabilities supporting Army combat formations. Will research and design common user interfaces for remote lethality with limited targeting assist. Will research automation software and algorithms, increased robotic reliability and function, and determine certified safety procedures for soldier-operated armed UGVs. Will conduct experiments using various commercial network solutions.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort realigns to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BF3 (Combat Vehicle Robotics Technology) as part of the financial restructuring.</p>		-	10.478	-
<p><i>Title:</i> FY 2019 SBIR / STTR Transfer</p> <p><i>Description:</i> FY 2019 SBIR / STTR Transfer</p> <p><i>FY 2019 Plans:</i> FY 2019 SBIR / STTR Transfer</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i></p>		-	0.582	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / <i>Combat Vehicle and Automotive Technology</i>	Project (Number/Name) H91 / <i>Ground Vehicle Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
FY 2019 SBIR / STTR Transfer			
Accomplishments/Planned Programs Subtotals	32.413	36.848	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / <i>Combat Vehicle and Automotive Technology</i>	Project (Number/Name) T26 / <i>Ground Vehicle Technologies (CA)</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
T26: <i>Ground Vehicle Technologies (CA)</i>	-	10.000	34.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	44.000

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 2018	FY 2019
Congressional Add: Program Increase	10.000	34.000
FY 2018 Accomplishments: Program Increase		
FY 2019 Plans: Program Increase		
Congressional Adds Subtotals	10.000	34.000

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>					R-1 Program Element (Number/Name) PE 0602618A / <i>Ballistics Technology</i>							
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	83.299	85.491	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	168.790
H80: <i>Survivability And Lethality Technology</i>	-	83.299	75.491	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	158.790
HB1: <i>SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)</i>	-	0.000	10.000	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.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602618A / <i>Ballistics Technology</i>
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This work is performed by the United States Army Futures Command.

B. Program Change Summary (\$ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	85.309	75.541	75.850	-	75.850
Current President's Budget	83.299	85.491	0.000	-	0.000
Total Adjustments	-2.010	9.950	-75.850	-	-75.850
• Congressional General Reductions	-0.042	-0.050			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	10.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.968	-			
• Adjustments to Budget Years	-	-	-75.850	-	-75.850

Change Summary Explanation

FY19 increase related to Congressional add of \$10 Million
FY20 increase related to Science and Technology restructuring

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602618A / <i>Ballistics Technology</i>				Project (Number/Name) H80 / <i>Survivability And Lethality Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H80: <i>Survivability And Lethality Technology</i>	-	83.299	75.491	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	158.790

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 2018	FY 2019	FY 2020
Title: Underbody Blast & Occupant Protection	1.443	-	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602618A / <i>Ballistics Technology</i>	Project (Number/Name) H80 / <i>Survivability And Lethality Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Description: This effort investigates and designs tools, techniques, and technologies for protection against mine/improvised explosive device (IED) blast threats, ballistic shock mitigation, and fuel/ammunition fires to enable survivability of current and future platforms.</p>				
<p>Title: Low Cost Hyper-Accuracy Munition Technologies</p> <p>Description: This effort designs advanced components/subsystems to enable a broad spectrum of future affordable direct and indirect fire precision munitions. The focus is on a multidisciplinary approach to munition systems design by coupling physics-based models of interior ballistics, launch dynamics, flight mechanics, and high-gravitational force guidance, navigation, and control technologies. The goal is for smaller, cheaper and lighter munition components enabling low-collateral-damage precision munitions for future asymmetric operations in military operations in urban terrain (MOUT).</p>		3.624	-	-
<p>Title: Disruptive Energetics and Propulsion Technologies</p> <p>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.</p> <p>FY 2019 Plans: Develop scale-up capability of multiple classes of disruptive energetic materials, testing and performance evaluation of disruptive energetic materials; develop computational methodology to model/predict behavior for energetic materials in explosives and propellants composites at extreme conditions; develop mechanisms for modeling the gas-phase chemistry associated with the combustion of solid propellants; develop technologies to extend the range and velocity of small, medium and large caliber projectiles.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602141A (Lethality Technology) / Project AH6 (Disruptive Energetics and Propulsion Technologies) in FY20 as part of financial restructuring.</p>		8.222	7.902	-
<p>Title: Lethal and Scalable Effects Technologies</p> <p>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.</p> <p>FY 2019 Plans:</p>		5.569	6.336	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602618A / <i>Ballistics Technology</i>	Project (Number/Name) H80 / <i>Survivability And Lethality Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Explore new materials and architectures to reduce the weapon mass required to launch and deliver lethal mechanisms; experimentally demonstrate the ability to modify high energy muzzle blast fields; explore warhead concepts that can simultaneously defeat multiple targets.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602141A (Lethality Technology) / Project AH5 (Projectile and Multi-Function Warhead Technologies) and Project AH7 (Lethal and Scalable Effects Technologies) in FY20 as part of financial restructuring.</p>				
<p>Title: Survivability/Lethality Analyses</p> <p>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.</p> <p>FY 2019 Plans: Design and develop new analytical methodologies and models to assess the highest priority new foreign and American technologies with the highest likelihood of affecting the ballistic survivability of Soldiers and fielded and developmental Army system; conduct experiments to characterize high resolution, time dependent penetration and failure mechanisms in ballistic events and will exploit for applied mechanism that can be used in future Army systems; continue to investigate energy-efficient penetrator and warhead concepts for direct-fire, distributed, and cooperative lethality scenarios; develop deeper understanding of the science associated with non-lethal incapacitation.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BG6 (Advanced Concepts for Active Defense Technology) in FY20 as part of financial restructuring.</p>		7.318	6.424	-
<p>Title: Multi-Threat Armor Formulations and Designs</p> <p>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).</p> <p>FY 2019 Plans: Mature promising multi-threat armor designs utilizing hybrid electromagnetic armor (EMA)/energetic technologies; verify results both computationally and experimentally.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement:</p>		18.640	19.101	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602618A / <i>Ballistics Technology</i>	Project (Number/Name) H80 / <i>Survivability And Lethality Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BG6 (Advanced Concepts for Active Defense Technology) in FY20 as part of financial restructuring.				
<p>Title: Adaptive and Cooperative Protection Technologies</p> <p>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.</p> <p>FY 2019 Plans: Will conduct computational and experimental research to mature/optimize promising adaptive armor designs.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BG6 (Advanced Concepts for Active Defense Technology) in FY20 as part of financial restructuring.</p>		6.238	11.909	-
<p>Title: Ballistic and Blast Protection for Dismounted Soldiers</p> <p>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.</p> <p>FY 2019 Plans: Investigate the physics of failure for emerging threats utilizing high definition experiments to identify phenomena and calibrate the ballistic models; finalize injury models for soft and hard tissues for ballistic impact.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project AZ5 (Soldier Protection Technology ? Vulnerability) in FY20 as part of financial restructuring.</p>		6.545	6.134	-
<p>Title: Warrior Injury Assessment Manikin (WIAMan)</p> <p>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.</p> <p>FY 2019 Plans:</p>		6.292	3.919	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602618A / <i>Ballistics Technology</i>	Project (Number/Name) H80 / <i>Survivability And Lethality Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
Complete injury biomechanics testing and injury assessment reference curves; validate finite element model for Generation-1 ATD for risk assessment capabilities; complete injury analysis tool development. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BG6 (Advanced Concepts for Active Defense Technology) in FY20 as part of financial restructuring.				
Title: Vulnerability Assessment of Technologies Description: This effort reviews high-priority developmental technologies in the context of current and emerging threats, identifies tradeoffs, and develops risk reduction strategies to promote the development of technologies that are "threat ready?". State-of-the-art vulnerability assessment methodology and tools are applied across a broad spectrum of threats in order to investigate potential vulnerabilities and identify mitigation options early in the materiel development cycle.		8.686	-	-
Title: Active Protection Modeling and Technologies Description: This effort supports the development of Active Protection System (APS) technologies and common architecture to reduce vehicle weight while significantly increasing protection against current and emerging advanced threats by reducing reliance on armor through other means such as sensing, warning, and active countermeasures. The APS common architecture will provide adaptable APS solutions that can be integrated across Army vehicle platforms as required. This research includes the development of new modeling and simulation capabilities along with supporting experimental and theoretical approaches to enable active protective systems. This effort includes integrated information (e.g., battlefield geography, threat launch detection and tracking) and intelligence to inform protection optimization, requiring collaboration across multiple Army organizations.		5.253	-	-
Title: Swarming Weapons Technologies Description: This effort develops concepts for simultaneous and assured delivery of multiple lethal payloads at extended ranges to challenging (e.g., moving) targets in constrained and contested environments (such as highly dynamic and mixed personnel environments, and Global Positioning System denied environments) through the use of highly collaborative teaming and distributed intelligence, perception, estimation, and control theories and technologies.		4.618	-	-
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. FY 2019 Plans:		0.851	0.864	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602618A / <i>Ballistics Technology</i>	Project (Number/Name) H80 / <i>Survivability And Lethality Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
Perform limited V&V assessments of computational capability; transition ALEGRA and ALE3D models to Sandia and Livermore National Labs; develop 2d generation models. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BG6 (Advanced Concepts for Active Defense Technology) in FY20 as part of financial restructuring.				
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. FY 2019 Plans: Explore advanced protection and lethal mechanisms to enable the next generation combat vehicle and small autonomous systems; seek to model operational effects based on laboratory/range experiments. FY 2019 to FY 2020 Increase/Decrease Statement: FY20 funds realigned to PE 0602145A (NGCV Technology) / Project BG6 (Advanced Concepts for Active Defense Technology) as part of financial restructure.		-	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. FY 2019 Plans: Conduct free-flight computational and experimental investigation of enhanced open-loop control maneuver technologies in subsonic regime; study structural response of control mechanism technologies for extremely high-G (>60kGs) launch survivability; investigate gun-launched morphing airframe technologies using computational and experimental methods; validate anchored and unanchored localization technologies for navigation in denied environments on low-speed vehicle in flight experiments and on high-speed vehicle in high-fidelity simulation. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602147A (Long Range Precision Fires Technology) / Project AH4 (Precision and Coop Weapons in a Denied Env Tech) in FY20 as part of financial restructuring.		-	9.058	-
Title: FY 2019 SBIR / STTR Transfer		-	1.650	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602618A / <i>Ballistics Technology</i>	Project (Number/Name) H80 / <i>Survivability And Lethality Technology</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
Description: FY 2019 SBIR / STTR Transfer			
FY 2019 Plans: FY 2019 SBIR / STTR Transfer			
FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer			
Accomplishments/Planned Programs Subtotals	83.299	75.491	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602618A / <i>Ballistics Technology</i>	Project (Number/Name) HB1 / <i>SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
HB1: <i>SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)</i>	-	0.000	10.000	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 2018	FY 2019	FY 2020
Title: Congressional Increase	-	10.000	-
Description: Congressional increase.			
FY 2019 Plans: Congressional increase.			
FY 2019 to FY 2020 Increase/Decrease Statement: Congressional Increase in FY19.			
Accomplishments/Planned Programs Subtotals	-	10.000	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602622A / <i>Chemical, Smoke and Equipment Defeating Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	3.895	5.027	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	8.922
552: <i>Smoke/Novel Effect Mun</i>	-	3.895	5.027	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	8.922

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 (Countermines & 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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	4.004	5.032	5.612	-	5.612
Current President's Budget	3.895	5.027	0.000	-	0.000
Total Adjustments	-0.109	-0.005	-5.612	-	-5.612
• Congressional General Reductions	-0.002	-0.005			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.107	-			
• Adjustments to Budget Years	-	-	-5.612	-	-5.612

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army Date: March 2019

Appropriation/Budget Activity
2040: *Research, Development, Test & Evaluation, Army / BA 2: Applied Research*

R-1 Program Element (Number/Name)
PE 0602622A / *Chemical, Smoke and Equipment Defeating Technology*

Change Summary Explanation

FY20 decrease related to Science and Technology financial restructuring.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602622A / <i>Chemical, Smoke and Equipment Defeating Technology</i>	Project (Number/Name) 552 / <i>Smoke/Novel Effect Mun</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>552: Smoke/Novel Effect Mun</i>	-	3.895	5.027	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	8.922

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)

Title: Advanced Obscurants	FY 2018	FY 2019	FY 2020
<i>Description:</i> This effort investigates new materials and compounds to enable safe, effective screening of personnel and equipment.	1.481	1.514	-
FY 2019 Plans: Will continue to mature and characterize advanced bispectral, will advanced microwave and spectrally selective obscurants.			
FY 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602622A / <i>Chemical, Smoke and Equipment Defeating Technology</i>	Project (Number/Name) 552 / <i>Smoke/Novel Effect Mun</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BG8 (Obscuration Technology) in FY20 as part of the financial restructuring.				
<p>Title: Obscurant Enabling Technology</p> <p>Description: This effort investigates distribution technologies for various obscurants.</p> <p>FY 2019 Plans: Will document vulnerability studies analyses. Will develop new vehicle protection concepts based on vulnerability studies of anti-tank guided missiles. Will continue to conduct vulnerability studies of various technologies to obscurant/target defeat effects.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BG8 (Obscuration Technology) in FY20 as part of the financial restructuring.</p>		0.966	1.950	-
<p>Title: Forensic Analysis of Explosives</p> <p>Description: This effort investigates forensics analytical methods for military explosives, homemade explosives (HME), HME precursors, and residue analysis for attribution.</p> <p>FY 2019 Plans: Will investigate Photonic Integrated Circuits for chemical sensing of explosives, narcotics, and other chemicals of interest for forensic analysis and personnel borne detectors. Will investigate metal organic framework polymer composites to enhance selectivity in explosives detection.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602144A (Ground technology) / Project BL2 (Explosive Forensics Technology) i Fy20 as part of the financial restructuring.</p>		1.448	1.420	-
<p>Title: FY 2019 SBIR / STTR Transfer</p> <p>Description: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 Plans: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer</p>		-	0.143	-
Accomplishments/Planned Programs Subtotals		3.895	5.027	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602622A / <i>Chemical, Smoke and Equipment Defeating Technology</i>	Project (Number/Name) 552 / <i>Smoke/Novel Effect Mun</i>

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602623A / <i>Joint Service Small Arms Program</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	6.473	12.380	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	18.853
H21: <i>Jt Svc Sa Prog (JSSAP)</i>	-	6.473	12.380	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	18.853

Note

In Fiscal Year (FY) 2020, this Program Element (PE) is being eliminated, with continuity of effort to the following PE:
 * PE 0602143A Soldier Lethality Technology

A. Mission Description and Budget Item Justification

This Program Element (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 FY18/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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	5.615	12.394	5.031	-	5.031
Current President's Budget	6.473	12.380	0.000	-	0.000
Total Adjustments	0.858	-0.014	-5.031	-	-5.031
• Congressional General Reductions	-0.004	-0.014			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	1.039	-			
• SBIR/STTR Transfer	-0.177	-			
• Adjustments to Budget Years	-	-	-5.031	-	-5.031

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602623A / <i>Joint Service Small Arms Program</i>	
<u>Change Summary Explanation</u> FY20 decrease related to Science & Technology financial restructuring.		

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602623A / Joint Service Small Arms Program				Project (Number/Name) H21 / Jt Svc Sa Prog (JSSAP)			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H21: Jt Svc Sa Prog (JSSAP)	-	6.473	12.380	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	18.853

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 FY18/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 2018	FY 2019	FY 2020
Title: Weapon System and Enablers	1.881	1.860	-
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.			
FY 2019 Plans: Design and develop barrel and suppressor technologies to dissipate heat, and withstand higher chamber pressures as well as muzzle velocities. This design will yield increased small arms weapon performance.			
FY 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602623A / <i>Joint Service Small Arms Program</i>	Project (Number/Name) H21 / <i>Jt Svc Sa Prog (JSSAP)</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project AY6 (Soldier Squad Small Arms Armaments Technology) in FY20 as part of the financial restructuring.				
<p>Title: Small Arms Ammunition Research</p> <p>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.</p> <p>FY 2019 Plans: Design and develop component technologies for a family of small arms ammunition in support of the Next Generation Squad Weapon that will result in increased probability of hit and effects on targets. Types of ammunition technologies to mature will include: enhanced performance round, advanced penetrating projectile, tracer round, reduced range training round ammunition (RRTA) and a RRTA tracer projectile.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project AY6 (Soldier Squad Small Arms Armaments Technology) in FY20 as part of the financial restructuring.</p>		3.937	9.802	-
<p>Title: Small Arms Technology Applied Research</p> <p>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.</p> <p>FY 2019 Plans: Incorporate small arms ammunition weapon technologies research into the Small Arms Ammunition Research project; continue to investigate small arms technologies capable to defeat current and future threats to the dismounted warfighter as well as able to increase hit probabilities, kinetic speed to target, and decreased engagement time.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project AY6 (Soldier Squad Small Arms Armaments Technology) in FY20 as part of the financial restructuring.</p>		0.655	0.300	-
<p>Title: FY 2019 SBIR / STTR Transfer</p> <p>Description: FY 2019 SBIR / STTR Transfer</p>		-	0.418	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602623A / <i>Joint Service Small Arms Program</i>	Project (Number/Name) H21 / <i>Jt Svc Sa Prog (JSSAP)</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<i>FY 2019 Plans:</i> FY 2019 SBIR / STTR Transfer			
<i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> FY 2019 SBIR / STTR Transfer			
Accomplishments/Planned Programs Subtotals	6.473	12.380	-

C. Other Program Funding Summary (\$ in Millions)
N/A

Remarks

D. Acquisition Strategy
N/A

E. Performance Metrics
N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: Research, Development, Test & Evaluation, Army / BA 2: Applied Research	R-1 Program Element (Number/Name) PE 0602624A / Weapons and Munitions Technology
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	241.344	383.410	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	624.754
H18: Weapons & Munitions Technologies	-	20.886	18.229	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	39.115
H19: Asymmetric & Counter Measure Technologies	-	3.198	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.198
H1A: WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE (CA)	-	204.000	343.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	547.000
H28: Warheads/Energetics Technologies	-	13.260	22.181	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	35.441

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.

In FY18/FY19 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), PE 0602141A (Lethality Technology), and PE 0602146A (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.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602624A / <i>Weapons and Munitions Technology</i>
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The work in this PE is performed by the United States Army Futures Command (AFC).

B. Program Change Summary (\$ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	41.455	40.444	46.783	-	46.783
Current President's Budget	241.344	383.410	0.000	-	0.000
Total Adjustments	199.889	342.966	-46.783	-	-46.783
• Congressional General Reductions	-0.022	-0.034			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	204.000	343.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	3.039	-			
• SBIR/STTR Transfer	-1.050	-			
• Adjustments to Budget Years	-6.078	-	-46.783	-	-46.783

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: H1A: *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE (CA)*

- Congressional Add: *Program Increase*
- Congressional Add: *Extended Range Cannon Artillery*
- Congressional Add: *Sensor Fuzed Munition*
- Congressional Add: *Laser Weapons Accuracy*
- Congressional Add: *Defense Against Small UAS*
- Congressional Add: *120 mm Cannon Fired Guided Missile*
- Congressional Add: *Weapons Effectiveness in Urban Engagement*
- Congressional Add: *Armament Systems Integration*
- Congressional Add: *Armament Systems Concepting*
- Congressional Add: *Adv Processing of Insensitive Energ Mats*
- Congressional Add: *Hybrid Projectile Tech*
- Congressional Add: *Composite Barrel Tech*
- Congressional Add: *Railgun Weapon Tech*
- Congressional Add: *Enhanced Extended Range Artillery System*

	FY 2018	FY 2019
	18.000	25.000
	20.000	20.000
	20.000	20.000
	15.000	23.000
	20.000	30.000
	10.000	50.000
	15.000	15.000
	20.000	20.000
	20.000	20.000
	6.000	20.000
	5.000	10.000
	10.000	10.000
	25.000	-
	-	67.000

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602624A / <i>Weapons and Munitions Technology</i>
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Congressional Add Details (\$ in Millions, and Includes General Reductions)

Congressional Add: *Novel Printed Armaments Components*

	FY 2018	FY 2019
	-	13.000
Congressional Add Subtotals for Project: H1A	204.000	343.000
Congressional Add Totals for all Projects	204.000	343.000

Change Summary Explanation

FY18 increase related to congressional adds totaling \$204 Million
 FY19 increase related to congressional adds totaling \$343 Million
 FY20 decrease related to Science and Technology financial restructuring

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602624A / <i>Weapons and Munitions Technology</i>				Project (Number/Name) H18 / <i>Weapons & Munitions Technologies</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H18: <i>Weapons & Munitions Technologies</i>	-	20.886	18.229	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	39.115

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 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

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Novel Propulsion Technology for the Future	3.429	2.849	-
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.			
FY 2019 Plans: Investigate alternative processing methods amenable to achieving high-energy formulations in spheroidal and/or pancake geometries in conjunction with development of high-energy propellant formulations; will investigate processing methods, material synthesis and formulation to support development of encapsulated propellant, which could result in improved stability/			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602624A / <i>Weapons and Munitions Technology</i>	Project (Number/Name) H18 / <i>Weapons & Munitions Technologies</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
sensitivity and combustion profiles without sacrificing combustion performance; Validate the optimized electrode configuration and formulation for electrically controlled energetic materials (ECEM).				
FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602147A (Long Range Precision Fires Technology) / Project AG6 (Energetic Materials and Advanced Processing Techno) in FY20 as part of the financial restructuring.				
Title: Advanced Weapons Technology Description: This effort investigates innovative weapon technologies such as recoil energy mitigation, affordable precision, extended range/guided technologies, and advanced propellant for future medium caliber direct fire systems that could provide similar or greater lethality than current systems.		0.824	-	-
Title: Affordable Precision Technologies Description: This effort investigates technologies that provide affordable precision capabilities for projectiles fired into Global Positioning System (GPS) denied environments. FY 2019 Plans: Investigate the optimal architecture for an Automatic Target Recognition (ATR) capable Precision Guided Munition (PGM); Include initial system trade studies, modeling of various seeker types on candidate indirect fire platform systems and experimental assessments of high risk critical components. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort realigned to PE 0602147A (Long Range Precision Fires Technology) / Project AG4 (Extended Range Artillery Munition Suite Technology) in FY20 as part of the financial restructuring.		3.015	2.586	-
Title: Extended Range Indirect Fire Weapon Technology Description: This effort initially investigates and determines the viability of candidate extended range indirect fire weapon technologies that facilitate light weight armaments with launch velocities resulting in ranges of 70km and beyond with emerging ammunition. Technologies will be applied at the system and sub-system level to address technology gaps.		2.783	-	-
Title: Long Range Gun Technology Development Description: This effort investigates and develops candidate extended range artillery weapon system and projectile technologies that increase the range up to 2x with increased precision.		1.500	-	-
Title: Fuze and Power Technologies for Munitions		2.080	1.029	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602624A / <i>Weapons and Munitions Technology</i>	Project (Number/Name) H18 / <i>Weapons & Munitions Technologies</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2019 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 as well as Counter-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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602147A (Long Range Precision Fires Technology) / Project BN5 (Fuze and Power for Munitions) in FY20 as part of the financial restructuring.</p>			
<p>Title: Cluster Munitions Replacement Acceleration</p> <p>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.</p> <p>FY 2019 Plans: This effort will begin to validate the tactical designs for all concepts, and will investigate incorporating additional features into the design of critical components; will improve insensitive munitions (IM) performance as well as investigate and determine what other technologies could be incorporated into the materiel solutions as a potential improvements.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This effort is completed in FY19.</p>	6.431	1.023	-
<p>Title: Programmable Intelligent Collaborative Engagement Munition</p> <p>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.</p> <p>FY 2019 Plans:</p>	0.824	1.463	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602624A / <i>Weapons and Munitions Technology</i>	Project (Number/Name) H18 / <i>Weapons & Munitions Technologies</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
Will design and develop hardware and mature algorithms and concepts validated in the prior year to a breadboard state; will utilize hardware and software in the loop testbed to validate collaboration across multiple munitions in flight. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602147A (Long Range Precision Fires Technology) / Project AG4 (Extended Range Artillery Munition Suite Technology) in FY20 as part of the financial restructuring.				
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. FY 2019 Plans: 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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602148A (Future Vertical Lift Technology) / Project AK6 (Advanced Rotorcraft Armaments Protection System Te) in FY20 as part of the financial restructuring.		-	4.453	-
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. FY 2019 Plans: Will investigate RF seeker component technologies with a focus on projectile payload performance, size, weight, power, and gun launch survivability; will perform systems engineering and detailed performance analyses to determine the trade space when integrating these RF seeker technologies in gun-launched environments. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort realigned to PE 0602147A (Long Range Precision Fires Technology) / Project AG4 (Extended Range Artillery Munition Suite Technology) in FY20 as part of the financial restructuring.		-	1.463	-
Title: ARCHER		-	2.925	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602624A / <i>Weapons and Munitions Technology</i>	Project (Number/Name) H18 / <i>Weapons & Munitions Technologies</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2019 Plans: Will investigate and mature command guided, medium caliber projectile designs on a tactical turret platform; will research and develop novel warhead and projectile stabilization architectures; will conduct lab experiments to mature designs of projectile critical components; will validate reliability, functionality and performance of various projectile component technologies; will research the target defeat effectiveness of material solutions for various concepts and develop algorithms based on armament system requirements.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This effort is completed in FY19.</p>			
<p>Title: FY 2019 SBIR / STTR Transfer</p> <p>Description: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 Plans: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer</p>	-	0.438	-
Accomplishments/Planned Programs Subtotals	20.886	18.229	-

<p>C. Other Program Funding Summary (\$ in Millions) N/A</p> <p>Remarks</p> <p>D. Acquisition Strategy N/A</p> <p>E. Performance Metrics N/A</p>
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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602624A / Weapons and Munitions Technology				Project (Number/Name) H19 / Asymmetric & Counter Measure Technologies			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H19: Asymmetric & Counter Measure Technologies	-	3.198	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.198

Note

In Fiscal Year (FY) 2020 this Project will realign to:
 Program Element (PE) 0602141A Lethality Technology
 * Project A11 Advanced terrain Shaping Technology
 PE 0602143A Soldier Lethality Technology
 * Project AY8 Small Arms Fire Control Technology
 PE 0602145A Next Generation Combat Vehicle Technology
 * Project BK3 Next Gen Intelligent Fire Control (NG-IFC) Tech

A. Mission Description and Budget Item Justification

This Project designs and develops technologies to support advanced fire control for indirect fires such as efforts to maintain the lethality and overmatch of United States (US) weapons against current and future threat systems. Work in this Project is related to, and fully coordinated with, efforts in Projects H18 and H28 (also in PE 0602624A), PE 0602618A (Ballistics Technology), and Projects 232 and L94 in PE 0603004A (Weapons and Munitions Advanced Technology).

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 2018	FY 2019	FY 2020
Title: Enhanced Fire Control for Indirect Fires	3.198	-	-
Description: This effort evaluates the applicability and integration of state-of-the-art acquisition and engagement technologies for data and image processing, weapon orientation sensors and methodologies to enhance fire control capability, and therefore weapon effectiveness, at various ranges and under battlefield conditions. Investigates components and architectures that will reduce size, weight, power and cost (SWaP-C), and increase commonality and operation across direct and indirect fire control systems.			
Accomplishments/Planned Programs Subtotals	3.198	-	-

C. Other Program Funding Summary (\$ in Millions)

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602624A / Weapons and Munitions Technology	Project (Number/Name) H19 / Asymmetric & Counter Measure Technologies

C. Other Program Funding Summary (\$ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602624A / Weapons and Munitions Technology				Project (Number/Name) H1A / WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE (CA)			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H1A: WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE (CA)	-	204.000	343.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	547.000

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 2018	FY 2019
Congressional Add: Program Increase	18.000	25.000
FY 2018 Accomplishments: Program Increase		
FY 2019 Plans: Program Increase		
Congressional Add: Extended Range Cannon Artillery	20.000	20.000
FY 2018 Accomplishments: Extended Range Cannon Artillery		
FY 2019 Plans: Extended Range Cannon Artillery		
Congressional Add: Sensor Fuzed Munition	20.000	20.000
FY 2018 Accomplishments: Sensor Fuzed Munition		
FY 2019 Plans: Sensor Fuzed Munition		
Congressional Add: Laser Weapons Accuracy	15.000	23.000
FY 2018 Accomplishments: Laser Weapons Accuracy		
FY 2019 Plans: Laser Weapons Accuracy		
Congressional Add: Defense Against Small UAS	20.000	30.000
FY 2018 Accomplishments: Defense Against Small UAS		
FY 2019 Plans: Defense Against Small UAS		
Congressional Add: 120 mm Cannon Fired Guided Missile	10.000	50.000

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602624A / <i>Weapons and Munitions Technology</i>	Project (Number/Name) H1A / <i>WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE (CA)</i>
B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019
FY 2018 Accomplishments: 120 mm Cannon Fired Guided Missile		
FY 2019 Plans: 120 mm Cannon Fired Guided Missile		
Congressional Add: Weapons Effectiveness in Urban Engagement	15.000	15.000
FY 2018 Accomplishments: Weapons Effectiveness in Urban Engagement		
FY 2019 Plans: Weapons Effectiveness in Urban Engagement		
Congressional Add: Armament Systems Integration	20.000	20.000
FY 2018 Accomplishments: Armament Systems Integration		
FY 2019 Plans: Armament Systems Integration		
Congressional Add: Armament Systems Concepting	20.000	20.000
FY 2018 Accomplishments: Armament Systems Concepting		
FY 2019 Plans: Armament Systems Concepting		
Congressional Add: Adv Processing of Insensitive Energetics	6.000	20.000
FY 2018 Accomplishments: Adv Processing of Insensitive Energetics		
FY 2019 Plans: Adv Processing of Insensitive Energetics		
Congressional Add: Hybrid Projectile Tech	5.000	10.000
FY 2018 Accomplishments: Hybrid Projectile Tech		
FY 2019 Plans: Hybrid Projectile Tech		
Congressional Add: Composite Barrel Tech	10.000	10.000
FY 2018 Accomplishments: Composite Barrel Tech		
FY 2019 Plans: Composite Barrel Tech		
Congressional Add: Railgun Weapon Tech	25.000	-
FY 2018 Accomplishments: Railgun Weapon Tech		
Congressional Add: Enhanced Extended Range Artillery System	-	67.000

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602624A / <i>Weapons and Munitions Technology</i>	Project (Number/Name) H1A / <i>WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE (CA)</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019
<i>FY 2019 Plans:</i> Enhanced Extended Range Artillery System		
<i>Congressional Add:</i> Novel Printed Armaments Compnents	-	13.000
<i>FY 2019 Plans:</i> Novel Printed Armaments Compnents		
Congressional Adds Subtotals	204.000	343.000

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602624A / Weapons and Munitions Technology	Project (Number/Name) H28 / Warheads/Energetics Technologies
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H28: Warheads/Energetics Technologies	-	13.260	22.181	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	35.441

Note

In Fiscal Year (FY) 2020 this Project will be funded in:
 Program Element (PE) 0602141A Lethality Technology
 * Project AH9 Advanced Warheads Technology
 PE 0602147A Long Range Precision Fires Technology
 * Project AG6 Energetic Materials and Adv Processing Tech
 * 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)

Title: Scalable Warhead Technology	FY 2018	FY 2019	FY 2020
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.	5.211	5.830	-
FY 2019 Plans:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602624A / <i>Weapons and Munitions Technology</i>	Project (Number/Name) H28 / <i>Warheads/Energetics Technologies</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Will mature and down select various warhead components (mini SC liners, mini explosively formed penetrator (EFPs) and multi-EFPs) for insertion into follow-on Advanced Technology Development efforts; validate effectiveness of selected concepts against simulated and actual threats.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: Effort ends in FY19</p>				
<p>Title: Advanced Energetics (formerly named Explosives Research)</p> <p>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.</p> <p>FY 2019 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; will investigate reaction kinetics for ingredient synthesis applicable to advanced flow reactors; will design and develop processing parameters necessary to produce energetic materials for additive manufacturing; will develop novel modeling and simulation tools required to accurately predict energetic materials performance in novel and unique geometries.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602147A (Long Range Precision Fires Technology) / Project AG8 (Energetic Materials and Adv Processing Tech) in FY20 as part of the financial restructuring.</p>		6.001	8.099	-
<p>Title: Tunable Pyrotechnics</p> <p>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.</p> <p>FY 2019 Plans: Will develop an integrated solution for the Dazzler Counter Measure to include new pyrotechnic formulations; will develop and modify ASCM formulations based on static and functional tests to assess viability of technology candidates; will investigate new countermeasure designs in the electromagnetic (EM) spectrum to address emerging threats.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602148A (Future Vertical Lift Technology) / Project AK2 (Aviation Survivability Technology) in FY20 as part of the financial restructuring.</p>		2.048	3.615	-
<p>Title: Advanced Warheads</p>		-	4.023	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602624A / <i>Weapons and Munitions Technology</i>	Project (Number/Name) H28 / <i>Warheads/Energetics Technologies</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2019 Plans: Will characterize new family of materials for designs of novel micro warheads to achieve fragmentation, EFP and shaped charge effects; will conduct parametric study to establish the performance and lethal effects of novel warhead designs.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602141A (Lethality Technology) / Project AH9 (Advanced Warheads Technology) in FY20 as part of the financial restructuring.</p>				
<p>Title: FY 2019 SBIR / STTR Transfer</p> <p>Description: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 Plans: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer</p>		-	0.614	-
Accomplishments/Planned Programs Subtotals		13.260	22.181	-
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				
E. Performance Metrics				
N/A				

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: Research, Development, Test & Evaluation, Army / BA 2: Applied Research	R-1 Program Element (Number/Name) PE 0602705A / Electronics and Electronic Devices
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	90.613	96.760	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	187.373
EM4: Electric Component Technologies (CA)	-	33.000	38.500	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	71.500
EM8: High Power And Energy Component Technology	-	10.416	12.575	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	22.991
H11: Tactical And Component Power Technology	-	8.215	7.655	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	15.870
H17: Flexible Display Center	-	2.063	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	2.063
H94: Elec & Electronic Dev	-	36.919	38.030	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	74.949

Note

In Fiscal Year (FY) 2020 this Program Element (PE) is being 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

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602705A / <i>Electronics and Electronic Devices</i>
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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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	58.352	58.283	57.741	-	57.741
Current President's Budget	90.613	96.760	0.000	-	0.000
Total Adjustments	32.261	38.477	-57.741	-	-57.741
• Congressional General Reductions	-0.015	-0.023			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	33.000	38.500			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.724	-			
• Adjustments to Budget Years	-	-	-57.741	-	-57.741

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: EM4: *Electric Component Technologies (CA)*

Congressional Add: *Flexible Hybrid Electronics Tech*

Congressional Add: *Protective & Anti-Tamper Tech for Electronic Attack*

Congressional Add: *Silicon Carbide Electronics Research*

Congressional Add: *Position Navigation Timing Systems*

Congressional Add: *Tactical Power Generation and Storage Systems*

Congressional Add Subtotals for Project: EM4

Congressional Add Totals for all Projects

	FY 2018	FY 2019
	7.000	5.000
	10.000	-
	16.000	20.000
	-	8.500
	-	5.000
Congressional Add Subtotals for Project: EM4	33.000	38.500
Congressional Add Totals for all Projects	33.000	38.500

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602705A / <i>Electronics and Electronic Devices</i>	
<u>Change Summary Explanation</u> FY18 increase related to congressional add funding of \$33 Million FY19 increase related to congressional add funding of \$38.5 Million FY20 decrease related to Science and Technology financial restructuring		

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602705A / <i>Electronics and Electronic Devices</i>				Project (Number/Name) EM4 / <i>Electric Component Technologies (CA)</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
EM4: <i>Electric Component Technologies (CA)</i>	-	33.000	38.500	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	71.500

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 2018	FY 2019
Congressional Add: Flexible Hybrid Electronics Tech	7.000	5.000
FY 2018 Accomplishments: Flexible Hybrid Electronics Tech		
FY 2019 Plans: Flexible Hybrid Electronics Tech		
Congressional Add: Protective & Anti-Tamper Tech for Electronic Attack	10.000	-
FY 2018 Accomplishments: Protective & Anti-Tamper Tech for Electronic Attack		
Congressional Add: Silicon Carbide Electronics Research	16.000	20.000
FY 2018 Accomplishments: Silicon Carbide Electronics Research		
FY 2019 Plans: Silicon Carbide Electronics Research		
Congressional Add: Position Navigation Timing Systems	-	8.500
FY 2019 Plans: Position Navigation Timing Systems		
Congressional Add: Tactical Power Generation and Storage Systems	-	5.000
FY 2019 Plans: Tactical Power Generation and Storage Systems		
Congressional Adds Subtotals	33.000	38.500

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / <i>Electronics and Electronic Devices</i>	Project (Number/Name) EM4 / <i>Electric Component Technologies (CA)</i>

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602705A / <i>Electronics and Electronic Devices</i>				Project (Number/Name) EM8 / <i>High Power And Energy Component Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
EM8: <i>High Power And Energy Component Technology</i>	-	10.416	12.575	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	22.991

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 Tank and Automotive Research, Development, and Engineering Center (TARDEC); Armaments Research, Development, and Engineering Center (ARDEC); the Army Aviation and Missile Research, Development, and Engineering Center (AMRDEC); and the Army Communications-Electronics Research, Development, and Engineering Center (CERDEC); and the United States Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT).

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / <i>Electronics and Electronic Devices</i>	Project (Number/Name) EM8 / <i>High Power And Energy Component Technology</i>
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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 2018	FY 2019	FY 2020
<p>Title: Advanced Solid-State Laser Technology and Integrated Photonic Technologies</p> <p>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</p> <p>FY 2019 Plans: Investigate innovative fully crystalline fiber designs, in particular, the ?crystalline core/crystalline cladding? design (a.k.a. CCCC or C4) developed to enable high energy laser power scaling out of single fiber laser aperture to >10X compared to the current state-of-the-art; explore alternative Raman fiber designs for power scaling of direct diode cladding pumped Raman fiber lasers; and develop structures, devices, and architectures to enable optical phased arrays capable of free space optical communications and ranging, and timing and position synchronization needed for mobile platforms.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned PE 0602150A (Air and Missile Defense Technology) / Project AD2 (High Energy Laser (HEL) Enabling and Support Tech) in FY20 as part of financial restructuring.</p>	1.790	2.000	-
<p>Title: Electronic Attack Technologies/Spectrum Sensing and Exploitation</p> <p>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).</p> <p>FY 2019 Plans: Develop neutralization techniques for autonomous vehicles; will investigate remote determination of target susceptibility; and explore next-generation cognitive radar performance in realistic congested and contested spectral environment. Design and</p>	2.456	1.788	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / <i>Electronics and Electronic Devices</i>	Project (Number/Name) EM8 / <i>High Power And Energy Component Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
develop EA, ES, and EP tools, techniques and methodologies for the highest priority Army systems and technologies for which electronic warfare is a critical threat.				
FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602146A (Network C3I Technology) / Project AP5 (Electronic Warfare Technology) in FY20 as part of the financial restructuring.				
Title: Electronic Components and Materials Research		2.993	3.090	-
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.				
FY 2019 Plans: Perform measurements on aluminum gallium nitride (AlGaN) high electron mobility transistor (HEMT) devices to demonstrate improved efficiencies and breakdown characteristics based on enhanced ohmic contacts, locally doped p-type regions using ion implantation, and AlGaN films grown on either high quality GaN or aluminum nitride (AlN) substrates; refine high speed motor drive model and utilize model to study wide bandgap (WBG) device performance; characterize WBG device performance using the motor test stand; and investigate WBG devices for high speed high voltage motor drives and tactical power conversion.				
FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle) / Project BH7 (Enhanced VETRONICS Technology) in FY20 as part of the financial restructuring.				
Title: Power System Components Integration and Control Research		3.177	-	-
Description: Research the configuration of electronic components and control strategies required to achieve high-power density and high-efficiency power utilization in current and future platform sub-systems, and vehicle and micro-grid (installation) applications, to include the operation of military-specific power distribution topologies at the circuit and system levels.				
Title: Advanced Distributed Power for Autonomous Platforms		-	1.405	-
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				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / <i>Electronics and Electronic Devices</i>	Project (Number/Name) EM8 / <i>High Power And Energy Component Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>mobility capabilities. Research addresses current and future Army-unique power delivery challenges in compact autonomous air and ground platforms.</p> <p>FY 2019 Plans: Investigate power control topologies that provide low speed high torque motor operation; explore power distribution and conversion methods for power generation that enhance fault tolerance and provide graceful degradation; investigate high voltage switching and power packaging for application in conversion and distribution for autonomous platform mobility and power generation; and perform research in compact power switching, conversion and distribution technologies to produce fast, high energy electrical discharge to provide unique mobility enhancements through application of high voltage phenomenology.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle) / Project BF8 (Artificial Intelligence & Machine Learning Tech) in FY20 as part of the financial restructuring.</p>				
<p>Title: RF Electronic Attack/Surveillance (Grey C3)</p> <p>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.</p> <p>FY 2019 Plans: Investigate techniques for distributed EA and ES from handheld platforms; and validate commercial off-the-shelf (COTS) and government off-the-shelf (GOTS) software-defined radios for use as surrogate development hardware.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602146A (Network C3I Technology) / Project A02 (Stand-In Advanced RF Effects (STARE)) in FY20 as part of the financial restructuring.</p>		-	2.000	-
<p>Title: Vulnerability Analysis Methodology for CEMA threats</p> <p>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.</p> <p>FY 2019 Plans:</p>		-	2.000	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / <i>Electronics and Electronic Devices</i>	Project (Number/Name) EM8 / <i>High Power And Energy Component Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
Design and develop a vulnerability analysis and susceptibility profile methodology based on current simulation and experimental methods for cyber and electromagnetic threats. Investigate and validate methodology to improve Protect, Detect, React, and Restore assessments through automation and advanced analytics.				
FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602146A (Network C3I Technology) / Project AP4 (CEMA Camouflage Technology) in FY20 as part of the financial restructuring.				
Title: FY 2019 SBIR / STTR Transfer		-	0.292	-
Description: FY 2019 SBIR / STTR Transfer				
FY 2019 Plans: FY 2019 SBIR / STTR Transfer				
FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer				
Accomplishments/Planned Programs Subtotals		10.416	12.575	-
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				
E. Performance Metrics				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602705A / <i>Electronics and Electronic Devices</i>				Project (Number/Name) H11 / <i>Tactical And Component Power Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H11: <i>Tactical And Component Power Technology</i>	-	8.215	7.655	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	15.870

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 2018	FY 2019	FY 2020
Title: Tactical Power Generation Technology	3.508	2.906	-
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.			
FY 2019 Plans: Will complete optimization of electromechanical component technology designs in kinetic energy harvesting devices for maximum power generation and conversion efficiency to enable continuous, distributed operations; continue investigation of power			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / <i>Electronics and Electronic Devices</i>	Project (Number/Name) H11 / <i>Tactical And Component Power Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>generating techniques with significant power densities including ultra-capacitor technology; complete the optimization and integration of high voltage cathode materials into representative battery cells to validate designs and assess energy density advancements; complete the development of Silicon Anode and Lithium Sulfur cell materials for advanced lithium primary and rechargeable battery cell packs that enables a 2x improvement in performance; research novel chemistries and balance of plant materials for smaller, lighter, wearable / portable fueled power sources to enable continuous power generation and platoon battery charging.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project BD8 (Soldier & SM Unit Tactical Energy Tech) in FY20 as part of the financial restructuring.</p>				
<p>Title: Energy Informed Operations</p> <p>Description: This effort investigates power management technologies, components and systems to increase the efficiency of energy output, reduce weight and increase reliability, while increasing fuel and cost efficiency across battlefield environments. This effort funds research in control and interface standards for effective power management, novel power distribution techniques, situational awareness, predictive, and prognostic and diagnostics capabilities for tactical power missions. This effort will also investigate scalable brass board designs for power management and distribution in support of missions in the 60 kilowatt (kW) ? 360kW range</p>		4.707	-	-
<p>Title: Optimized Energy for C4ISR Platforms</p> <p>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 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.</p> <p>FY 2019 Plans: Will investigate power requirements for emerging C4ISR capabilities to include directed energy, lasers, high power sensors, and electromagnetic weapons; conduct analysis of size, weight and power requirements necessary to support these capabilities with unique very high density power sources and energy storage for high rate pulsed power; identify interface requirements and constraints for power system; investigate architectures and intelligent controls necessary to manage these loads; investigate and perform high resolution characterization of cyclical, step and high power load profiles likely to result from use of lasers or other high power, short duration burst technology; examine thermal implications and waste heat generated from inefficiencies in power</p>		-	4.647	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / <i>Electronics and Electronic Devices</i>	Project (Number/Name) H11 / <i>Tactical And Component Power Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
conversation; explore hybrid energy storage technologies to support cyclical loads such as hybrid batteries or ultra-capacitor technology; determine dual use potential of microwave or laser power transmission technologies with other developmental operational uses; conduct experiments on wireless power transmission capabilities for laser power transmission; explore the use of intelligent control strategies for platform integrated power systems. <i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> The research effort was realigned to PE 0602148A (Future Vertical Lift Technology) / Project AM4 (Energy Stg & Therm Mgmt for FVL Survivability) in FY20 as part of the financial restructuring.				
<i>Title:</i> FY 2019 SBIR / STTR Transfer <i>Description:</i> FY 2019 SBIR / STTR Transfer <i>FY 2019 Plans:</i> FY 2019 SBIR / STTR Transfer <i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> FY 2019 SBIR / STTR Transfer		-	0.102	-
Accomplishments/Planned Programs Subtotals		8.215	7.655	-
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				
E. Performance Metrics				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602705A / <i>Electronics and Electronic Devices</i>				Project (Number/Name) H17 / <i>Flexible Display Center</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H17: <i>Flexible Display Center</i>	-	2.063	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	2.063

Note

This Project concluded in Fiscal Year (FY) 2018.

A. Mission Description and Budget Item Justification

The flexible electronics program conducts applied research on the integration of electronics, power components, and sensors on non-traditional flexible substrates. The program builds upon two-dimensional (2D) flexible electronics to incorporate the integration of electronic components, power systems, and sensors into three-dimensional (3D) flexible architectures. The research includes electronic modeling, design, fabrication, and analysis. The applied research supports the demonstration of Army-relevant sensors on flexible substrates for Army applications such as monitoring of the human state.

This Project 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 (AFC).

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Flexible Electronics Development (previously Flexible Display Center (FDC) and Flexible Electronics Development)	2.063	-	-
Description: The flexible electronics program is advancing applied research towards the integration of electronics, power components, and sensors on non-traditional flexible substrates and into 3D architectures.			
Accomplishments/Planned Programs Subtotals	2.063	-	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602705A / <i>Electronics and Electronic Devices</i>				Project (Number/Name) H94 / <i>Elec & Electronic Dev</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H94: <i>Elec & Electronic Dev</i>	-	36.919	38.030	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	74.949

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 and Communications, 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.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / <i>Electronics and Electronic Devices</i>	Project (Number/Name) H94 / <i>Elec & Electronic Dev</i>

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 2018	FY 2019	FY 2020
<p>Title: Antennas, Microwave Components, and Millimeter Wave Imaging</p> <p>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.</p> <p>FY 2019 Plans: Perform in-situ simulations of low-profile antennas and propagation; integrate and characterize new antenna and RF electronics to improve the performance of the helicopter situational awareness radar and study the fusion of these radars with other hostile fire sensor modalities; enhance efforts for material driven antenna designs to include evolving antenna additive manufacturing through the investigation of higher dielectric feed stock and conductive printed metals; produce novel, complex and conformal multiband array designs that are not cost effective to produce with current commercial materials; design enabling components for transmitter architectures that supports complex digital modulations in the presence of very strong nonlinearities; study enabling devices and integrated circuits at millimeter-wave frequencies at the advent of 5G and newly competed spectrum; develop machine learning techniques/algorithms for RF modulation recognition.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602148A (Future Vertical Lift Technology) / Project AL8 (Holistic Situational Awareness and Dec Making Tech) and PE 0602150A (Air and Missile Defense Technology) / Project AD5 (Next Generation Fires Radar Technology) in FY20 as part of the financial restructuring.</p>	5.407	5.681	-
<p>Title: Advanced Micro and Nano Devices</p> <p>Description: This effort designs and characterizes micro- and nano-technology components for multi-functional and integrated RF applications, micro-robotics, integrated energetics, control sensor interfaces, and sensors for improved battlefield situational awareness.</p>	1.947	-	-
<p>Title: Survivability for Wireless Tactical Networks (formerly Security and Survivability for Wireless Tactical Networks)</p> <p>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</p>	1.567	0.750	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / <i>Electronics and Electronic Devices</i>	Project (Number/Name) H94 / <i>Elec & Electronic Dev</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2019 Plans: Investigate and develop cognitive networking algorithms that optimize media access control scheduling and network routing in resource constrained (e.g. energy, processing), congested and contested environments; implement energy and computationally efficient techniques to determine if resource constrained devices have been infiltrated and corrupted by an adversary; investigate approaches for adapting and optimizing communication modalities in response to adversarial activity; implement techniques for simulating and emulating large scale networks to enable analyzing the behavior of complex systems of networks in complex tactical operating environments.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This effort concludes after FY19.</p>			
<p>Title: Sensor Protection</p> <p>Description: This effort develops and characterizes materials for protection of electro-optic (EO) systems from lasers.</p> <p>FY 2019 Plans: Mature EO materials and supporting electronic components; validate speed and degree of protection of large-area EO shutters; conduct experiments to determine performance of tunable longwave IR filter designs.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle) / Project BI2 (Sensor Protection Technology) in FY20 as part of the financial restructuring.</p>	2.914	4.625	-
<p>Title: Applied Photonic and Optoelectronic Devices (formerly Hazardous Material Detection)</p> <p>Description: This effort models and develops materials and devices for the next generation Army sensor systems. Semiconductor materials and devices from ultraviolet (UV) to 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.</p> <p>FY 2019 Plans: Conduct three dimensional (3D) modeling of the device properties of mercury cadmium telluride semiconductor structures that utilize novel resonant architectures or carrier depletion techniques to reduce dark current and increase operating temperature of</p>	1.957	2.141	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / <i>Electronics and Electronic Devices</i>	Project (Number/Name) H94 / <i>Elec & Electronic Dev</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>IR detectors and thereby reduce the need for cryogenic cooling; design and develop near ultraviolet laser sources based upon semi-polar and non-polar III-Nitride semiconductor heterostructures to enable compact and low cost ion-based quantum devices for networking; continue development and characterization of molecularly imprinted polymers as a chemical detection filter / concentrator for studying asymmetric threats.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This effort concludes after FY19.</p>				
<p>Title: Power and Thermal Management for Small Systems</p> <p>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.</p> <p>FY 2019 Plans: Demonstrate integrated thermophotovoltaic generator with overall system efficiency improved through an integrated heat recuperator and demonstrate multiple "simple" fuels, including single component hydrocarbons and surrogate fuels for more complex fuels like JP-8; use experimental results to validate models developed as part of this objective for the different fuel and catalyst material combinations.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project BD8 (Soldier & Sm Unit Tactical Energy Tech) in FY20 as part of the financial restructuring.</p>		0.891	0.903	-
<p>Title: Power and Energy</p> <p>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.</p> <p>FY 2019 Plans: Improve the efficiency of dual intercalation electrodes for inexpensive grid energy storage; investigate additives to limit dendrite formation of lithium metal batteries for high energy density rechargeable batteries; investigate all-solid-state chemistries for safe lithium batteries; analyze and interpret the results of the investigation of new methods for reduced aging improved duration of thermal batteries performed in FY18; determine through modeling or conducting experiments the performance of these methods; investigate nanocomposite non-noble catalysts and acid-alkaline bipolar membrane electrolyte interface and single cell</p>		2.783	1.671	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / <i>Electronics and Electronic Devices</i>	Project (Number/Name) H94 / <i>Elec & Electronic Dev</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
performance; integrate semipermeable membrane materials and electrolytes via hybrid bi-cell and bipolar membrane technologies to address costs and balance-of-plant issues. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602144A (Ground Technology) / Project BL1 (Materials and Manufacturing Research Technology) and PE 0602145A (Next Generation Combat Vehicle / Project BJ3 (Hydrogen Based Combat System Technology) in FY20 as part of the financial restructuring.				
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 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. FY 2019 Plans: Incorporate broad-angle anti-reflection / rear surface light trapping structure matched to response spectrum of optimized hybrid quantum-mechanical based solar cell; investigate novel thermal energy harvesting including elastocalorics and pyroelectrics; develop plasmonically enhanced water and urea splitting device; develop the capability of enhancing catalytic reactions using infrared radiation; develop antimonide-doped gallium nitride water splitting device; demonstrate methanol production from Carbon Dioxide (CO2) through reduction processes in the present of sunlight. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project BD8 (Soldier & Sm Unit Tactical Energy Tech) in FY20 as part of the financial restructuring.		2.764	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		5.538	5.513	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / <i>Electronics and Electronic Devices</i>	Project (Number/Name) H94 / <i>Elec & Electronic Dev</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2019 Plans: Design and fabricate advanced node silicon and gallium nitride integrated circuits implementing Soldier Radio Waveform with 3X reduction in power draw; characterize carrier transport in semiconductor laser diode structures for the development of large area UV emitters; investigate processes to make 3-D electrode structures and investigate their effect on energy storage chemistry rates and ionic and electronic transports; investigate solid-state chemistries for safe lithium batteries; develop MEMS-based and resonant RF sensors that can passively sense an RF signal while consuming < 10 nW of power for zero-power-consuming sleep mode electronics; determine the efficiency and power transfer limits of laser-to-pyroelectric wireless power transfer; explore acoustic power transfer with the ability to steer the acoustic beam source using arrays of acoustic transducers; design and develop near-ultraviolet laser sources based upon semi-polar and non-polar III-nitride semiconductor heterostructures to enable compact and low cost ion-based quantum devices for networking.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602146A (Network C3I Technology) / Project AO4 (Energy Efficient Devices Technology) in FY20 as part of the financial restructuring.</p>			
<p>Title: Precision Measurement Technology for Contested Environments (Technologies for Anti Access / Area Denial)</p> <p>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 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.</p> <p>FY 2019 Plans: Develop robust object recognition, efficient simultaneous localization and mapping and interactive topological mapping methods and integrate them into low size, weight and power - Cost (SWAP-C) platforms; investigate novel information sources to passively locate humans in a complex and cluttered environment; design, fabricate and characterize an integrated MEMS and</p>	2.941	2.983	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / <i>Electronics and Electronic Devices</i>	Project (Number/Name) H94 / <i>Elec & Electronic Dev</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>heterogeneous sensor solution for increased state estimation accuracy; improve positioning, navigation, and timing (PNT) sensor fusion algorithms to include input from a heterogeneous array of aiding sensors in diverse environments; assemble wearable anti-jam GPS test-bed and study performance of body-distributed anti-jam GPS antennas in laboratory environment; design and characterize an asymmetric free-space optical link that uses a retro-reflector to measure the time delay between the transmitter and receiver and uses a modulated laser to develop low SWAP-C free-space optical time transfer techniques; investigate deep learning based approaches for perception, including scene, landmark and skyline recognition on computationally constrained platforms to enable geo-localization without GPS; continue to develop and optimize material fabrication process for construction of environmentally stable Epsilon-Near-Zero oscillator materials and devices.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This effort is complete after FY19.</p>				
<p>Title: Anti-Tamper (AT) Technology Development</p> <p>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.</p> <p>FY 2019 Plans: Develop threat-based sensors and secure processor Intellectual Property (IP) to support Rigor technology refresh; manufacture full Rigor 1b engineering models; complete laboratory characterization of Rigor 1b module; continue design and development of Rigor 1a module; and develop Rigor 1a test-modules.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602146A (Network C3I Technology) / Project AV5 (Protective Technologies) in FY20 as part of the financial restructuring.</p>		5.025	5.900	-
<p>Title: Cognitive Countermeasures Technology Development</p> <p>Description: This effort investigates and matures novel materials, components, and techniques to counter legacy and emerging threats to Army 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.</p>		2.010	-	-
<p>Title: Technologies for Alternative Energy</p> <p>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.</p>		1.175	1.191	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / <i>Electronics and Electronic Devices</i>	Project (Number/Name) H94 / <i>Elec & Electronic Dev</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p><i>FY 2019 Plans:</i> Develop improved thermoelectric materials, with a goal of >2X improvement (>10%) conversion efficiency for low temperature differences near 1000 C; assemble and validate battery or pseudo-capacitor packs for both electrochemical and safety.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project BD8 (Soldier & Sm Unit Tactical Energy Tech) in FY20 as part of the financial restructuring.</p>				
<p><i>Title:</i> Quantum for Assured PNT in Zero-GPS Environments Acceleration</p> <p><i>Description:</i> 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.</p> <p><i>FY 2019 Plans:</i> Design integrated triaxial MEMS Internal measurement units (IMUs) with 3 orders of magnitude improvement in accuracy (goal TRL4 in FY21), develop approach/design for integrated photonics and quantum timing circuit that meets PNT timing requirements while meeting on Soldier SWAP-C goals, and to build optical time synchronization demonstration for FY20/TRL3 demonstration.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned to PE 0602146A (Network C3I Technology) / Project AV9 (Advanced PNT for GPS Independent Environments Technologies) in FY20 as part of the financial restructuring.</p>		-	3.201	-
<p><i>Title:</i> FY 2019 SBIR / STTR Transfer</p> <p><i>Description:</i> FY 2019 SBIR / STTR Transfer</p> <p><i>FY 2019 Plans:</i> FY 2019 SBIR / STTR Transfer</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> FY 2019 SBIR / STTR Transfer</p>		-	0.449	-
Accomplishments/Planned Programs Subtotals		36.919	38.030	-
C. Other Program Funding Summary (\$ in Millions)				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / <i>Electronics and Electronic Devices</i>	Project (Number/Name) H94 / <i>Elec & Electronic Dev</i>

C. Other Program Funding Summary (\$ in Millions)
Remarks

D. Acquisition Strategy
N/A

E. Performance Metrics
N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602709A / <i>Night Vision Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	38.243	33.573	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	71.816
H95: <i>Night Vision And Electro-Optic Technology</i>	-	34.243	29.573	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	63.816
K90: <i>NIGHT VISION COMPONENT TECHNOLOGY (CA)</i>	-	4.000	4.000	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:

- * 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).

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602709A / <i>Night Vision Technology</i>
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B. Program Change Summary (\$ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	34.723	29.582	36.267	-	36.267
Current President's Budget	38.243	33.573	0.000	-	0.000
Total Adjustments	3.520	3.991	-36.267	-	-36.267
• Congressional General Reductions	-0.010	-0.009			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	4.000	4.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.470	-			
• Adjustments to Budget Years	-	-	-36.267	-	-36.267

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: K90: *NIGHT VISION COMPONENT TECHNOLOGY (CA)*

Congressional Add: *Night Vision Component Technology*

	FY 2018	FY 2019
	4.000	4.000
Congressional Add Subtotals for Project: K90	4.000	4.000
Congressional Add Totals for all Projects	4.000	4.000

Change Summary Explanation

FY19 increase related to congressional add of \$4 Million
 FY20 decrease related to Science and Technology financial restructuring

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602709A / <i>Night Vision Technology</i>				Project (Number/Name) H95 / <i>Night Vision And Electro-Optic Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H95: <i>Night Vision And Electro-Optic Technology</i>	-	34.243	29.573	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	63.816

Note

In Fiscal Year (FY) 2020 this Project is being 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 2018	FY 2019	FY 2020
Title: Distributed Aided Target Recognition (AiTR) Evaluation Center of Excellence	2.106	-	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602709A / <i>Night Vision Technology</i>	Project (Number/Name) H95 / <i>Night Vision And Electro-Optic Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Description: This effort investigates a virtual, distributed capability to interactively process both real and simulated three-dimensional (3D) multispectral scenes for Defense-wide applications. Automatic target recognition (ATR) and ATR algorithms are evaluated against realistic operational scenarios, to include roadside threats/explosively formed projectiles, in aided or fully autonomous RSTA missions.</p>				
<p>Title: Sensor Modeling and Simulation Technology</p> <p>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.</p> <p>FY 2019 Plans: Continue to research and validate methods to model and simulate Electro-optic/Infrared (EO/IR) system performance for computer-aided prototyping and augmented reality applications through field data collection, lab measurements, simulation, signature, and algorithm research; research methods to model emerging active and passive EO/IR technologies, applications, and threats such as hostile fire and unattended aerial systems to contribute to sensor system design; investigate and validate target acquisition performance measures to address EO/IR sensor signature countermeasures; will investigate the application of commercial gaming technologies and augmented reality for modeling and simulation tools to create a rapid ability to assess EO/IR system designs.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project BD1 (Adv Soldier Sensors/Displays Tech for Dismounts) in FY20 as part of the financial restructuring.</p>		5.110	4.769	-
<p>Title: Advanced Multifunction Laser Technology</p> <p>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.</p> <p>FY 2019 Plans:</p>		5.037	5.128	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602709A / <i>Night Vision Technology</i>	Project (Number/Name) H95 / <i>Night Vision And Electro-Optic Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Complete investigation and perform down select of a MWIR laser configuration for threat sensor detection based on performance by different selected laser breadboards; identify the highest performing frequency conversion techniques for electrical efficiency; design and develop a lightweight and low power brass-board laser with greater than five Watts of power.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BJ2 (Tactical and Navigation Lasers Sensors Technology) in FY20 as part of the financial restructuring.</p>				
<p>Title: Three-Dimensional Micro-Electronics for Night Vision Sensors</p> <p>Description: The goal of this effort is to investigate new, microelectronics, reconfigurable optics, and display technologies to interface with emerging three-dimensional (3D) electronics processing. The ability to actively reconfigure optical elements will require investigation of new materials and lens designs to enable real time optical refocusing and extended fields of view. Micro-display technology will benefit from new integrated microelectronics by use of new and improved display materials which operate at lower powers and enable all weather, day/night visualization.</p>		6.076	-	-
<p>Title: Multi-Function Digital Readout Integrated Circuits for Cooled and Uncooled Focal Plane Arrays</p> <p>Description: The objective of this effort is the development of advanced two-Dimensional (2D) and 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.</p> <p>FY 2019 Plans: Will investigate and conduct experiments to validate real-time processing that will put multiple functions into a small package, while allowing for an on-the-move capability; will develop an on-chip non-uniformity correction (NUC) that demonstrates high frame rate dynamic motion compensation and on-chip stabilization IR imagery for improved dynamic range in a compact package.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BF9 (Sensors for Autonomous Operations and Surv Tech) in FY20 as part of the financial restructuring.</p>		6.334	7.356	-
<p>Title: Computational Imaging</p> <p>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</p>		4.413	2.182	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602709A / <i>Night Vision Technology</i>	Project (Number/Name) H95 / <i>Night Vision And Electro-Optic Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
and Uncooled FPAs to provide improved mounted and dismounted Soldier situational understanding in urban and complex terrain under low light and visibility conditions.				
<p>FY 2019 Plans: Will design novel optics, sensors, and processing approaches for day/night visualization; will conduct experiments of computational algorithms and optics combined with display and vision processing to identify improvements in target discrimination and visualization; will validate new optics for performing real-time detection.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This effort realigned to PE 0602145A Next Generation Combat Vehicle Technology/Project BF9 Sensors for Autonomous Operations and Surv Tech in FY20 due to financial restructure in support of Army Modernization Priorities.</p>				
<p>Title: High Sensitivity High Speed Uncooled Longwave Infrared (UCIR) Technology</p> <p>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.</p> <p>FY 2019 Plans: Will continue to conduct experiments and validate new class of highly sensitive uncooled infrared imaging arrays; will design high-dynamic range speed ROIC and leverage advancing commercial foundry processes.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BF9 (Sensors for Autonomous Operations and Surv Tech) in FY20 as part of the financial restructuring.</p>		5.167	5.071	-
<p>Title: Embedded Processing for Autonomous Sensors</p> <p>Description: This effort develops signal and image processing algorithms at the sensor to provide actionable information in contextually relevant manner to the decision maker.</p> <p>FY 2019 Plans: Will conduct market research on signal and image processing algorithms for autonomous applications; will investigate novel techniques for improving signal and image processing algorithms to perform functions such as scene labeling, and data association to enable autonomous functions; will research innovative approaches for data management and fusion which reduce information processing time.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement:</p>		-	4.712	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602709A / <i>Night Vision Technology</i>	Project (Number/Name) H95 / <i>Night Vision And Electro-Optic Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BH2 (C4ISR Modular Autonomy Technology) in FY20 as part of the financial restructuring.			
Title: FY 2019 SBIR / STTR Transfer	-	0.355	-
Description: FY 2019 SBIR / STTR Transfer			
FY 2019 Plans: FY 2019 SBIR / STTR Transfer			
FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer			
Accomplishments/Planned Programs Subtotals	34.243	29.573	-

C. Other Program Funding Summary (\$ in Millions)
N/A

Remarks

D. Acquisition Strategy
N/A

E. Performance Metrics
N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602709A / <i>Night Vision Technology</i>				Project (Number/Name) K90 / <i>NIGHT VISION COMPONENT TECHNOLOGY (CA)</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
K90: <i>NIGHT VISION COMPONENT TECHNOLOGY (CA)</i>	-	4.000	4.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	8.000

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Night Vision Component Technology applied research.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019
Congressional Add: Night Vision Component Technology	4.000	4.000
FY 2018 Accomplishments: Night Vision Component Technology		
FY 2019 Plans: Night Vision Component Technology		
Congressional Adds Subtotals	4.000	4.000

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602712A / <i>Countermines Systems</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	25.329	27.223	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	52.552
H24: <i>Countermines Tech</i>	-	19.794	15.234	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	35.028
H35: <i>Camouflage & Counter-Recon Tech</i>	-	5.535	5.989	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	11.524
HB2: <i>COUNTERMINE COMPONENT TECHNOLOGY (CA)</i>	-	0.000	6.000	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 (Countermines 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.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602712A / <i>Countermine Systems</i>
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B. Program Change Summary (\$ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	26.190	21.244	22.914	-	22.914
Current President's Budget	25.329	27.223	0.000	-	0.000
Total Adjustments	-0.861	5.979	-22.914	-	-22.914
• Congressional General Reductions	-0.017	-0.021			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	6.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.844	-			
• Adjustments to Budget Years	-	-	-22.914	-	-22.914

Change Summary Explanation

FY19 increase related to congressional add of \$6 Million
 FY20 decrease related to science and technology financial restructuring

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602712A / <i>Countermine Systems</i>				Project (Number/Name) H24 / <i>Countermine Tech</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H24: <i>Countermine Tech</i>	-	19.794	15.234	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	35.028

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 2018	FY 2019	FY 2020
Title: Standoff Sensors for Explosive Hazard Detection	10.935	10.903	-
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.			
FY 2019 Plans: Will design and validate novel sensors and processing approaches using advances in correlated FL and multistate GPR, vibration, and EO/IR sensors; will combine fused signal processing methods to better detect targets in the presence of clutter in the natural environment; will develop new processing techniques to improve detection capability of complementary sensors in varying environments; will investigate modular sensor components including unique radars, EO/IR sensors, wire detection techniques, and sensitive radio frequency technologies to remotely detect explosive hazards and indicators of emplacement such as command wires and initiation devices for application to small unmanned air and ground platforms.			
FY 2019 to FY 2020 Increase/Decrease Statement:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602712A / <i>Countermine Systems</i>	Project (Number/Name) H24 / <i>Countermine Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
This research effort was realigned to PE 0602144A (Ground Technology) / Project BL4 (Countermine Technology) and PE 0602145A (Next Generation Combat Vehicle Technology) / Project BJ7 (Detection of Explosive Hazards Technology) in FY20 as part of the financial restructuring.				
<p>Title: Dismounted Explosive Hazard Detection Technology</p> <p>Description: This effort investigates emerging component technologies to enhance detection of explosive hazards, including metallic and non-metallic landmines, Improvised Explosive Devices (IEDs), Home Made Explosives (HMEs), and Explosively Formed Penetrators (EFPs). Emphasis is on increased coverage area, higher detection rates, and increased discrimination probabilities. Technologies that provide low Size, Weight, and Power (SWaP) solutions are considered and studied to ensure solutions are viable for Soldier-portable applications. This effort also investigates advanced signal processing and detection algorithms for increased real-time feedback for threat detection and identification, and it collects data to inform studies investigating methods to reduce the operator's cognitive burden.</p>		6.288	-	-
<p>Title: Counter Explosive Hazard Phenomonology</p> <p>Description: This effort investigates potential long term solutions to nonconventional explosive hazard threats. It leverages recent lessons learned to investigate new ideas and emerging counter explosive hazard (CEH) technologies by gaining a better understanding of how to detect, neutralize, and mitigate the threat. The effort includes a series of innovative exploration and discovery events focused on the identification of new ideas and concepts in a structured and organized framework, enabling the Army to identify/investigate opportunities to leverage technologies traditionally associated with other arenas, such as the intelligence community, big data, and the financial industry.</p>		2.571	-	-
<p>Title: Neutralization and Breaching Technology</p> <p>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.</p> <p>FY 2019 Plans: Will investigate standoff confirmation sensor techniques to determine discrimination thresholds and to set parameters for the design of neutralization techniques; will investigate laser, radio frequency, and microwave sources to determine maturity; determine options for use of explosive techniques.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement:</p>		-	3.900	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602712A / <i>Countermine Systems</i>	Project (Number/Name) H24 / <i>Countermine Tech</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned to PE 0602144A (Ground Technology) / Project BL4 (Countermine Technology) and PE 0602145A (Next Generation Combat Vehicle Technology) / Project BJ7 (Detection of Explosive Hazards Technology) in FY20 as part of the financial restructuring.			
Title: FY 2019 SBIR / STTR Transfer	-	0.431	-
Description: FY 2019 SBIR / STTR Transfer			
FY 2019 Plans: FY 2019 SBIR / STTR Transfer			
FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer			
Accomplishments/Planned Programs Subtotals	19.794	15.234	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602712A / <i>Countermine Systems</i>				Project (Number/Name) H35 / <i>Camouflage & Counter-Recon Tech</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H35: <i>Camouflage & Counter-Recon Tech</i>	-	5.535	5.989	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	11.524

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 2018	FY 2019	FY 2020
<p>Title: Camouflage and Counter-Reconnaissance Technology for Advanced Spectral Sensors</p> <p>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.</p> <p>FY 2019 Plans: Investigate new protective coatings for dual band IR systems that have high out of band rejection, very high in-band transmission, and laser durability while still meeting camera window environmental performance requirements; will continue to support signature characteristics testing for urban and arctic camouflage solutions for both vehicles and dismounted Soldiers.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BI2 (Sensor Protection Technology) in FY20 as part of the financial restructuring.</p>	5.535	5.791	-
<p>Title: FY 2019 SBIR / STTR Transfer</p> <p>Description: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 Plans:</p>	-	0.198	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602712A / <i>Countermine Systems</i>	Project (Number/Name) H35 / <i>Camouflage & Counter-Recon Tech</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
FY 2019 SBIR / STTR Transfer			
<i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> FY 2019 SBIR / STTR Transfer			
Accomplishments/Planned Programs Subtotals	5.535	5.989	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602712A / <i>Countermine Systems</i>				Project (Number/Name) HB2 / <i>COUNTERMINE COMPONENT TECHNOLOGY (CA)</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
HB2: <i>COUNTERMINE COMPONENT TECHNOLOGY (CA)</i>	-	0.000	6.000	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 2018	FY 2019	FY 2020
Title: Congressional Increase	-	6.000	-
Description: Congressional increase.			
FY 2019 Plans: Congressional increase.			
FY 2019 to FY 2020 Increase/Decrease Statement: NA.			
Accomplishments/Planned Programs Subtotals	-	6.000	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602716A / <i>Human Factors Engineering Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	23.813	24.121	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	47.934
H70: <i>Human Fact Eng Sys Dev</i>	-	23.813	24.121	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	47.934

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).

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602716A / <i>Human Factors Engineering Technology</i>
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B. Program Change Summary (\$ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	24.127	24.131	24.596	-	24.596
Current President's Budget	23.813	24.121	0.000	-	0.000
Total Adjustments	-0.314	-0.010	-24.596	-	-24.596
• Congressional General Reductions	-0.006	-0.010			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.308	-			
• Adjustments to Budget Years	-	-	-24.596	-	-24.596

Change Summary Explanation

FY20 decrease related to science and technology financial restructuring.

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602716A / <i>Human Factors Engineering Technology</i>				Project (Number/Name) H70 / <i>Human Fact Eng Sys Dev</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H70: <i>Human Fact Eng Sys Dev</i>	-	23.813	24.121	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	47.934

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 2018	FY 2019	FY 2020
Title: Interfaces for Collaboration and Decision Making	2.656	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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602716A / <i>Human Factors Engineering Technology</i>	Project (Number/Name) H70 / <i>Human Fact Eng Sys Dev</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
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.				
<p>FY 2019 Plans: Develop initial capability for real-time empirical assessment of human cyber performance to include leveraging human digital behaviors (i.e. keystrokes, mouse-clicks, tool use, screen recordings); identify specifications for Soldier cyber security training needs in tactical environments; develop techniques and measures to assess cyber team effectiveness; create behavioral models of Soldier situation understanding and defense of enterprise-level networked operational environments; continue development of capabilities for dynamic human/agent cyber experimentation using cyber test-range for on-site and remote human-in-the-loop experiments with authoring and execution of repeatable cyber scenarios.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project BC3 (Soldier Decision Making & Communications Performance Tech) in FY20 as part of financial restructuring.</p>				
<p>Title: Human Performance Modeling</p> <p>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.</p>		0.506	1.025	-
<p>FY 2019 Plans: Investigate the use of Human Systems Integration (HSI) tools to validate the effects of autonomous systems on operator workload and mission performance; conduct human performance modeling tool maintenance, development, and support; continue to extend development of human accommodating analysis to quantify human resource costs in terms of manpower, personnel and training; develop training videos to support the HSI practitioners; explore the development of human agent assisted tools for supporting HSI evaluations and assessments.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project BC3 (Soldier Decision Making & Communications Performance Tech) in FY20 as part of financial restructuring.</p>				
<p>Title: Brain-Computer Interaction</p> <p>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</p>		3.530	1.230	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602716A / <i>Human Factors Engineering Technology</i>	Project (Number/Name) H70 / <i>Human Fact Eng Sys Dev</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>characterizing Soldier brain activity in operational contexts, and real-time techniques to integrate neurally-based information into systems designs.</p> <p>FY 2019 Plans: Develop novel multiclass rapid-serial visual presentation brain-computer interaction paradigms for improved integration with deep-learned computer vision; develop novel approaches for determining the optimal allocation of images across hybrid teams of computer vision and brain-computer interface-using humans for enhancing efficiency of image analysis.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BF6 (Crew Augmentation and Optimization Tech) in FY20 as part of financial restructuring.</p>				
<p>Title: Dismounted Soldier Performance</p> <p>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.</p> <p>FY 2019 Plans: Determine the performance thresholds associated with individual and small team performance as a function of physical and cognitive constraints; examine the distinctions between equipment configurations, including novel system interface approaches designed to improve performance metrics (e.g., timing, accuracy, mobility); continue to investigate the effects of human variability on the performance of small arms shooting accuracy, and will determine ways of mitigating negative effects; conduct studies that relate characteristics of individual Soldier weapon systems, ancillary equipment, and ammunition to dismounted Soldier shooting performance (accuracy and precision).</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: The effort ends in Fiscal Year (FY) 2019.</p>		5.156	1.375	-
<p>Title: Human-Robot Interaction</p> <p>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 Tank Automotive Research Development and Engineering Center (TARDEC).</p> <p>FY 2019 Plans: Extend advances in multimodal, bidirectional communications models, including natural language solutions for small teams, to enhance Soldier collaborations with multiple heterogeneous agents in a distributed operational environment; enhance models</p>		3.054	3.075	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602716A / <i>Human Factors Engineering Technology</i>	Project (Number/Name) H70 / <i>Human Fact Eng Sys Dev</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>of trust and transparency to include adaptive roles for both humans and agents and serve as basis for human centered design requirements in multi-agent systems; explore applications for bidirectional communication and trust and transparency to include both mounted and dismounted operations.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BF6 (Crew Augmentation and Optimization Tech) in FY20 as part of financial restructuring.</p>				
<p>Title: Understanding Socio-cultural Influence</p> <p>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.</p> <p>FY 2019 Plans: Continue to quantify the processes and proficiencies that are selected for and taught by practitioners who collect, process, and distribute sociocultural information within the Army; develop a predictive model of group behavior based on religion to augment Civil Affairs decision making; conduct preliminary experiments to explore methods for improving situational understanding and decision making when visualizing sociocultural information in virtual reality; leverage theory from cognitive science to inform experimentation.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: In FY19 this effort ends.</p>		2.060	2.025	-
<p>Title: Continuous Multi-Faceted Soldier Characterization for Adaptive Technologies</p> <p>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.</p> <p>FY 2019 Plans: Develop techniques and algorithms to collect, synchronize and integrate high resolution behavioral, physiological, environmental, and task-based sensor information with existing low-resolution multi-faceted assessment capability to enable continuous monitoring of an individual across a variety of timescales; develop capability for real-time group-based performance assessment incorporating multi-faceted individual metrics and social dynamics through integration of multiple, pervasive data sources.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement:</p>		2.159	1.600	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602716A / <i>Human Factors Engineering Technology</i>	Project (Number/Name) H70 / <i>Human Fact Eng Sys Dev</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BF6 (Crew Augmentation and Optimization Tech) in FY20 as part of financial restructuring.				
<p>Title: Training Effectiveness Research</p> <p>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.</p> <p>FY 2019 Plans: Conduct experiments with refined research-based integration of multi-sensor data (e.g. accuracy, communications, psycho-physiological, and/or movement/location) for automated measurement of critical training outcomes; explore and identify training effectiveness measures for collective training (mixed reality and live); explore and identify multi-sensor data for automated measurement of effective collective training outcomes.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project BC3 (Soldier Decision Making & Communications Performance Tech) and Project BE8 (Synthetic Training Environment (STE) Technology) in FY20 as part of financial restructuring.</p>		0.932	0.992	-
<p>Title: Soldier System Architecture</p> <p>Description: Soldier performance is affected by mission demands, environment, human characteristics, equipment, and technology. System development requires considering tradeoffs among these factors and sufficient data about them on which to base analyses. This effort will identify and develop human performance measures of effectiveness (MOEs) and measures of performance (MOPs) critical to performing individual and team tasks in a mission text. Tools and techniques for analysis of these tradeoffs will also be developed. Empirical data will be mined from existing sources or collected where gaps exist to inform the interaction among factors affecting Soldier mission performance for emerging technologies.</p>		1.000	-	-
<p>Title: Rapid Soldier Capability Enhancement</p> <p>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</p>		2.760	2.760	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602716A / <i>Human Factors Engineering Technology</i>	Project (Number/Name) H70 / <i>Human Fact Eng Sys Dev</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2019 Plans: Investigate augmentation applications, to understand functionality in mounted and dismounted operational environments; enhance models of performance and adaptation to facilitate more robust prediction of capability enhancement including short and long term adaptations and factors related to individual variability; enhance metrics for quantifying Soldier performance while using a system of augmentation agents in complex environments.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project BC3 (Soldier Decision Making & Communications Performance Tech) and Project BE8 (Synthetic Training Environment (STE) Technology) in FY20 as part of financial restructuring.</p>				
<p>Title: Tools for Assessing Human/Intelligent Team Performance</p> <p>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.</p> <p>FY 2019 Plans: Develop portable, ?plug and play? analysis toolkit that enables individualized assessment of a single human interacting with an intelligent agent in pseudo-controlled environments.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Projects AY6 (Soldier Squad Small Arms Armament Technology) in FY20 as part of financial restructuring.</p>		-	1.000	-
<p>Title: Explainable Intelligence Underlying Efficient Integration of Cognitive Assist Agents</p> <p>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.</p> <p>FY 2019 Plans:</p>		-	2.050	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602716A / <i>Human Factors Engineering Technology</i>	Project (Number/Name) H70 / <i>Human Fact Eng Sys Dev</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
Develop novel machine learning approaches for learning the optimal allocation of tasks across hybrid teams of humans and artificial intelligent agents; develop novel approaches to deep neural networks based on the underlying geometry of the data. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BF6 (Crew Augmentation and Optimization Tech) in FY20 as part of financial restructuring.				
Title: Soldier Focused Neurotechnologies 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. FY 2019 Plans: Determine and develop efficacy of novel materials for use in advanced validation tools for mobile brain-recording hardware; develop a framework describing the relationship between computational neural data features and the performance of corresponding neural state classifiers within non-ideal, noisy environments. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BF6 (Crew Augmentation and Optimization Tech) in FY20 as part of financial restructuring.		-	2.330	-
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. FY 2019 Plans: Identify and validate initial surrogate tasks and associated performance metrics against an anticipated urban terrain scenario; identify key quantitative measures and model their relationship to performance outcomes; characterize human movement variability in performance of and transitions between component tasks and responses to perturbations within movement through complex urban environment scenario. FY 2019 to FY 2020 Increase/Decrease Statement:		-	1.500	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602716A / <i>Human Factors Engineering Technology</i>	Project (Number/Name) H70 / <i>Human Fact Eng Sys Dev</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BB7 (Physical Augmentation Tech) in FY20 as part of financial restructuring.			
Title: FY 2019 SBIR / STTR Transfer	-	0.359	-
Description: FY 2019 SBIR / STTR Transfer			
FY 2019 Plans: FY 2019 SBIR / STTR Transfer			
FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer			
Accomplishments/Planned Programs Subtotals	23.813	24.121	-

C. Other Program Funding Summary (\$ in Millions)
N/A

Remarks

D. Acquisition Strategy
N/A

E. Performance Metrics
N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602720A / <i>Environmental Quality Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	34.118	19.469	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	53.587
048: <i>Ind Oper Poll Ctrl Tec</i>	-	2.832	0.992	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.824
835: <i>Mil Med Environ Crit</i>	-	7.712	6.271	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	13.983
895: <i>Pollution Prevention</i>	-	2.374	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	2.374
896: <i>Base Fac Environ Qual</i>	-	8.200	4.206	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	12.406
F35: <i>Environmental Quality Applied Research (CA)</i>	-	13.000	8.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	21.000

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).

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: Research, Development, Test & Evaluation, Army / BA 2: Applied Research	R-1 Program Element (Number/Name) PE 0602720A / Environmental Quality Technology
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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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	21.678	13.242	13.503	-	13.503
Current President's Budget	34.118	19.469	0.000	-	0.000
Total Adjustments	12.440	6.227	-13.503	-	-13.503
• Congressional General Reductions	-0.012	-0.008			
• Congressional Directed Reductions	-	-1.765			
• Congressional Rescissions	-	-			
• Congressional Adds	13.000	8.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-5.000	-			
• SBIR/STTR Transfer	-0.548	-			
• Adjustments to Budget Years	5.000	-	-13.503	-	-13.503

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: F35: Environmental Quality Applied Research (CA)

Congressional Add: Coatings Technology

Congressional Add: Mobile Environmental Containment Sensors

Congressional Add: UAS for UXO Detection

	FY 2018	FY 2019
	3.000	-
	6.000	8.000
	4.000	-
Congressional Add Subtotals for Project: F35	13.000	8.000
Congressional Add Totals for all Projects	13.000	8.000

Change Summary Explanation

FY18 increase related to congressional Increases totaling \$13 Million.
 FY19 increase related to congressional increases totaling \$8 Million.
 FY20 decrease related to science and technology financial restructuring.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602720A / <i>Environmental Quality Technology</i>	Project (Number/Name) 048 / <i>Ind Oper Poll Ctrl Tec</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
048: <i>Ind Oper Poll Ctrl Tec</i>	-	2.832	0.992	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.824

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 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 2018	FY 2019	FY 2020
Title: Sustainable Ranges and Lands	1.865	-	-
Description: This effort supports management of operations on ranges and training lands with the intent to reduce constraints and restrictions resulting from environmental regulations. Technologies are targeted toward solutions for environmental compliance and associated requirements, as well as solutions that will enhance training and testing operations.			
Title: Adaptive & Resilient Installations	0.967	0.992	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602720A / <i>Environmental Quality Technology</i>	Project (Number/Name) 048 / <i>Ind Oper Poll Ctrl Tec</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>Description: This effort develops sustainable, cost efficient, and effective facilities; and provides technologies and techniques for achieving resilient and sustainable installation and base operations.</p> <p>FY 2019 Plans: Follow a system of systems approach to develop an integrated installation computational model which fuses data from existing systems and programs of record to capture management business processes. Business intelligence dashboards will integrate and support synthesis and reporting across business processes and at all echelons, and fully integrate information infrastructure that presents and provides decision-ready knowledge.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602144A (Ground Technology) / Project BK7 (Robotics for Engineer Operations Technology) in FY20 as part of the financial restructuring.</p>			
Accomplishments/Planned Programs Subtotals	2.832	0.992	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602720A / <i>Environmental Quality Technology</i>	Project (Number/Name) 835 / <i>Mil Med Environ Crit</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>835: Mil Med Environ Crit</i>	-	7.712	6.271	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	13.983

Note

In Fiscal Year (FY) 2020 this Project is being 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 2018	FY 2019	FY 2020
Title: Life Cycle of Military Materials in the Environment	0.907	0.194	-
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.			
FY 2019 Plans:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602720A / <i>Environmental Quality Technology</i>	Project (Number/Name) 835 / <i>Mil Med Environ Crit</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
Investigate environmentally-friendly signature tonedown/alteration concepts for critical assets that integrate novel materials such as organics and nanomaterials, and characterize life cycle and environmental health and safety impacts of concealment/ countermeasure technologies. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602144A (Ground Technology) / Project BL5 (Expedient Passive Protection Technology) in FY20 as part of the financial restructuring.				
Title: Advanced Materials and Nanotechnology: Environmental Effects previously called Nanotechnology-Environmental Effects Description: This effort enables the Army's ability to field advanced nano-based technologies by appropriate identification and assessment of the environmental impacts of nanomaterials. The end result of this research is the development of tools that guide and influence the design of nanomaterials based on such factors as adverse effects on human health or on the environment.		3.062	-	-
Title: Risk Prediction and Decision Technologies Description: This effort enables the Army to predict and understand the fate and transport of Army-unique compounds and materials which improves the capability to detect, control, and remediate. This effort developed advanced engineering concepts utilizing advanced materials, biological processes, and nanomaterials in remediation processes.		3.743	-	-
Title: Rapid Risk Analysis of Fires Description: Develop proactive environment, safety, and occupational health risk assessment tools to ensure rapid fielding of energetics, propellants, and munitions. FY 2019 Plans: Develop robust procedures for the detection and quantification of carbon-based advanced materials at concentrations relevant to sustainability analysis; identify current and future trends in additive manufacturing technologies and materials of interest to the Army to evaluate environment, health, and safety impacts during development, transition, and acquisition. Proactive environment, safety, and occupational health risk assessment tools will facilitate rapid fielding of energetics propellants and munitions. FY 2019 to FY 2020 Increase/Decrease Statement: Effort ends in FY19		-	2.944	-
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	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602720A / <i>Environmental Quality Technology</i>	Project (Number/Name) 835 / <i>Mil Med Environ Crit</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p><i>FY 2019 Plans:</i> Investigate environmental forensic methodologies to provide geo-chemical resources to mission planners. Quantify contaminant microbial degradation/transformation activity in arctic and subarctic climates as a function of soil geochemistry and environmental flux to model contaminate fate and transport prediction for intelligence preparation on the battlefield.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned to PE 0602146A (Network C3I Technology) / Project AR3 (Intelligent Environmental Battlefield Awareness) in FY20 as part of the financial restructuring.</p>				
<p><i>Title:</i> Chemical Sensing in Contested Environments</p> <p><i>Description:</i> Develop advanced environmental sensor technologies to enable rapid collection and analysis for persistent surveillance in contested areas. This project will provide significant advances in research and development of each of the component steps (improved selectivity for passive samplers, functionalization of printable adsorption components, novel signal generation techniques, sensor arrays, etc.) to enable rapid collection and analysis.</p> <p><i>FY 2019 Plans:</i> Develop advanced environmental sensor technologies to enable rapid collection and analysis for persistent surveillance in contested areas</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> Effort ends in FY19.</p>		-	0.862	-
<p><i>Title:</i> FY 2019 SBIR / STTR Transfer</p> <p><i>Description:</i> FY 2019 SBIR / STTR Transfer</p> <p><i>FY 2019 Plans:</i> FY 2019 SBIR / STTR Transfer</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> FY 2019 SBIR / STTR Transfer</p>		-	0.269	-
Accomplishments/Planned Programs Subtotals		7.712	6.271	-
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602720A / <i>Environmental Quality Technology</i>	Project (Number/Name) 835 / <i>Mil Med Environ Crit</i>

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602720A / <i>Environmental Quality Technology</i>	Project (Number/Name) 895 / <i>Pollution Prevention</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>895: Pollution Prevention</i>	-	2.374	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	2.374

Note

Program ended after FY18.

A. Mission Description and Budget Item Justification

The Project develops pollution prevention technologies required to reduce/eliminate the environmental footprint resulting from the manufacture, maintenance, use, and surveillance of Army ordnance and other weapon systems. This Project researches and develops revolutionary technologies to eliminate or significantly reduce the environmental impacts that threaten the sustainment of production and maintenance facilities, training ranges and operational areas. The Project supports the transformation of the Army by ensuring that advanced energetic materials required for high-performance munitions (gun, rocket, missile propulsion systems, and warhead explosives) are devised to meet weapons lethality/survivability stretch goals in parallel with, and in compliance to, foreseeable sustainment requirements. Specific technology thrusts include environmentally-benign explosives developed with computer modeling using Department of Defense high-performance computing resources; novel energetics that capitalize on the unique behavior of nano-scale structures; chemically engineered explosive and propellant formulations produced with minimal environmental waste, long-storage lifetime, rapid/benign environmental degradation properties, and efficient extraction and reuse; and fuses, pyrotechnics, and initiators that are free from toxic chemicals. Other focus areas include toxic metal reductions from surface finishing processes, sustainable military paints and coatings to meet evolving environmental requirements and low global warming potential alternatives for refrigerants, fire suppressants and solvents.

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

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Pollution Prevention Technologies	2.374	-	-
Description: This effort develops pollution prevention technologies to reduce/eliminate the environmental footprint resulting from the manufacture, maintenance, use and surveillance of Army ordnance and other weapon systems.			
Accomplishments/Planned Programs Subtotals	2.374	-	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602720A / <i>Environmental Quality Technology</i>	Project (Number/Name) 895 / <i>Pollution Prevention</i>

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602720A / <i>Environmental Quality Technology</i>				Project (Number/Name) 896 / <i>Base Fac Environ Qual</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
896: <i>Base Fac Environ Qual</i>	-	8.200	4.206	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	12.406

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 2018	FY 2019	FY 2020
Title: Sustainable Ranges and Lands	4.010	-	-
Description: This effort provides ecosystem vulnerability assessment, analysis, monitoring, modeling, and mitigation technologies to support sustainable use of Army facilities, training lands, firing ranges, and airspace to reduce or eliminate environmental constraints to military missions. This effort targets integrated military land-appropriate management and control technologies for selected high priority Army land management issues including Threatened and Endangered Species (TES), Species at Risk (SAR), and invasive species. This effort enables effective management of training lands by understanding the cumulative impacts of training and non-training land use activities on critical natural resources under current and potential future climate conditions.			
Title: Military Materials in the Environment	4.190	-	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019	
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602720A / <i>Environmental Quality Technology</i>	Project (Number/Name) 896 / <i>Base Fac Environ Qual</i>	
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019
Description: This effort develops models to predict chemical behavior in simple and complex environmental media (e.g. soils, water). These models will allow for improved understanding of how compounds and materials will move, bind, and degrade when introduced into the environment.			
Title: Rapid Risk Analysis of Fires Description: Develop proactive assessment tools to shape and protect Army investments in next generation fires by delivering science based risk and environmental impact management strategies. FY 2019 Plans: Explore potential environmental, health and safety hazards associated with emerging chemical and material developments to counter advanced conventional threats. Standardize methods for predicting ecological hazards of military materials early in the acquisition development process enabling potential replacement chemicals and other materials. FY 2019 to FY 2020 Increase/Decrease Statement: Effort ends in FY19.		-	2.206
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. FY 2019 Plans: Investigate computational chemistry predictions of the physical and chemical properties of insensitive munitions compounds and their degradation products, to determine their fate and effects in arid and semiarid environments and to provide actionable information supporting situational awareness and influence tactical operations. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602146A (Network C3I Technology) / Project AR5 (Understanding the Environment as a Threat Technology) in FY20 as part of the financial restructuring.		-	2.000
Accomplishments/Planned Programs Subtotals		8.200	4.206
C. Other Program Funding Summary (\$ in Millions)			
N/A			
Remarks			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602720A / Environmental Quality Technology	Project (Number/Name) 896 / Base Fac Environ Qual

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602720A / <i>Environmental Quality Technology</i>	Project (Number/Name) F35 / <i>Environmental Quality Applied Research (CA)</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>F35: Environmental Quality Applied Research (CA)</i>	-	13.000	8.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	21.000

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 2018	FY 2019
<i>Congressional Add:</i> Coatings Technology	3.000	-
<i>FY 2018 Accomplishments:</i> Coatings Technology		
<i>Congressional Add:</i> Mobile Environmental Containment Sensors	6.000	8.000
<i>FY 2018 Accomplishments:</i> Mobile Environmental Containment Sensors		
<i>FY 2019 Plans:</i> Mobile Environmental Containment Sensors		
<i>Congressional Add:</i> UAS for UXO Detection	4.000	-
<i>FY 2018 Accomplishments:</i> UAS for UXO Detection		
Congressional Adds Subtotals	13.000	8.000

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602782A / <i>Command, Control, Communications Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	32.458	54.956	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	87.414
<i>779: Command, Control And Platform Electronics Tech</i>	-	12.638	11.144	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	23.782
<i>CY2: Applied Defensive Cyber</i>	-	0.000	8.257	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	8.257
<i>H92: Communications Technology</i>	-	19.820	35.555	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	55.375

Note

In Fiscal Year (FY) 2020 this Program Element (PE) is being 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 (Electronic Warfare Technology) , PE 0602705A (Electronics and Electronic Devices), PE 0603270A (EW Technology), PE 0603772A (Adv Tactical Computer Science & Sensor 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.

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).

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602782A / <i>Command, Control, Communications Technology</i>
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B. Program Change Summary (\$ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	33.123	55.003	49.895	-	49.895
Current President's Budget	32.458	54.956	0.000	-	0.000
Total Adjustments	-0.665	-0.047	-49.895	-	-49.895
• Congressional General Reductions	-0.013	-0.047			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.652	-			
• Adjustments to Budget Years	-	-	-49.895	-	-49.895

Change Summary Explanation

FY20 decrease related to science and technology financial restructuring.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602782A / <i>Command, Control, Communications Technology</i>				Project (Number/Name) 779 / <i>Command, Control And Platform Electronics Tech</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>779: Command, Control And Platform Electronics Tech</i>	-	12.638	11.144	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	23.782

Note

- In Fiscal Year (FY) 2020 this Project is being 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).

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602782A / <i>Command, Control, Communications Technology</i>	Project (Number/Name) 779 / <i>Command, Control And Platform Electronics Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Title: Assured Positioning, Navigation, and Timing (A-PNT)</p> <p>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.</p> <p>FY 2019 Plans: Research and investigate new and novel GPS-independent sensors; investigate innovative ways to use exiting PNT sensors; design and develop sensor fusion algorithms; develop portable sensor fusion core, allowing for a platform-agnostic solution for navigation in GPS denied or degraded environments that can be tailored based on mission or size, weight and power (SWAP) requirements; develop interfaces for GPS independent sensors, allowing connectivity with the portable sensor fusion core; continue investigation of miniature inertial sensors to augment PNT in GPS denied environments; continue research involving LIDAR odometry, visual navigation, and map building as potential sensor packages for use with the sensor fusion core; investigate new signals of opportunity for augmenting positioning and timing solutions on the battlefield; continue to improve localization and movement of an autonomous vehicle using PNT sensors through a complex environment; and continue to develop models of PNT sensors and conduct simulations of operational scenarios, especially under GPS challenged conditions.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602146A (Network C3I Technology) / Project AW1 (Autonomous Navigation Technology), Project AW3 (DoD PNT M&S Collaboration Initiative (CI) Technology), and Project AW5 (Modular GPS Independent Sensors Technology) in FY20 as part of the financial restructuring.</p>		7.114	6.356	-
<p>Title: Next Generation Mission Command Technologies</p> <p>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.</p> <p>FY 2019 Plans: Investigate and leverage relevant research and technology in pattern matching and cognitive science; develop data-driven decision tools with pre-populated decision models, user directed machine learning, and machine directed human learning to enhance the speed of decision making in high operational tempo environments; design a software framework to allow the dynamic connection of information sources and sensors to decision tools; and develop and validate visualization techniques that supply</p>		5.524	4.639	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602782A / <i>Command, Control, Communications Technology</i>	Project (Number/Name) 779 / <i>Command, Control And Platform Electronics Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
increased situational awareness, understanding, and recommendations based on the primary, secondary, and third order effects of decisions through the identification of patterns detected in available battle-space data, resulting in improved decision cycles for commanders and staff. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to 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), and Project AV6 (Airborne Engineering Support Technolog) in FY20 as part of the financial restructuring.				
Title: FY 2019 SBIR / STTR Transfer Description: FY 2019 SBIR / STTR Transfer FY 2019 Plans: FY 2019 SBIR / STTR Transfer FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer		-	0.149	-
Accomplishments/Planned Programs Subtotals		12.638	11.144	-
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602782A / <i>Command, Control, Communications Technology</i>				Project (Number/Name) CY2 / <i>Applied Defensive Cyber</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>CY2: Applied Defensive Cyber</i>	-	0.000	8.257	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	8.257

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)

Title: Defensive Cyber Operations	FY 2018	FY 2019	FY 2020
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.	-	6.641	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602782A / <i>Command, Control, Communications Technology</i>	Project (Number/Name) CY2 / <i>Applied Defensive Cyber</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p><i>FY 2019 Plans:</i> Research and validate cyber security technologies to improve the depiction, perception, and understanding of cyber space as it pertains to a commander's operational environment to speed actionable decisions; research cyber hardening methodologies for software, hardware, identities, and information to create trusted architectures and measures of provable identity, pedigree, and provenance; investigate robust built-in techniques that enable systems and networks to absorb, fight through, and adapt to adversary attacks; research and design autonomic techniques, models and algorithms to support convergence of defensive cyber, offensive cyber, Electronic Warfare (EW), and network/spectrum management information to improve decision response; research and validate block-chaining methodologies to trace and validate pedigree of tactical information as it traverses the network; research and validate robust non-intrusive identity authentication techniques that supports tactical access control; and will research models and algorithms that can provably determine a confidence factor associated with software vulnerability prioritization.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned to PE 0602213A (Network C3I Technology) / Projects CY9 (Decoy and Deterrence Technology), Project CY6 (Autonomous Cyber Technology) and Project 2CY (Information Trust Technology) in FY20 as part of the financial restructuring.</p>				
<p><i>Title:</i> Cyber Security Applied Research & Experimentation Partner (AREP) Technology (formerly called the Cyber Collaborative Research Alliance (CRA))</p> <p><i>Description:</i> 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.</p> <p><i>FY 2019 Plans:</i> Investigate and validate artificial intelligence and machine learning models and methods for reasoning on real time vulnerability prediction/analysis at a system-of-system perspective; investigate use of modeling methodologies and techniques to capture and specify system properties (e.g., structural and behavioral), and characterize cybersecurity attributes (e.g., confidentiality, integrity and availability); investigate biological-inspired self-securing models and methods that can support capabilities to autonomously perform analytic monitoring, maintain dynamic representation, realign their resources as necessary, and be able to substantiate integrity; and will investigate models and methods that can estimate what likely impact a vulnerability will cause to a system or network based on incomplete and inaccurate data.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i></p>		-	1.616	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602782A / <i>Command, Control, Communications Technology</i>	Project (Number/Name) CY2 / <i>Applied Defensive Cyber</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned to PE 0602213A (Network C3I Technology) / Project CY8 (Cyber Sec Applied Research and Exper Partner Tech) in FY20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	8.257	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602782A / <i>Command, Control, Communications Technology</i>				Project (Number/Name) H92 / <i>Communications Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H92: <i>Communications Technology</i>	-	19.820	35.555	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	55.375

Note

In Fiscal Year (FY) 2020 this Project is being 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.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602782A / <i>Command, Control, Communications Technology</i>	Project (Number/Name) H92 / <i>Communications Technology</i>

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

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
<p>Title: Communications, Adaptive Networks to Improve Maneuver Operations, formerly Networking to Improve Maneuver and Expeditionary Operations</p> <p>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.</p> <p>FY 2019 Plans: Design and develop exquisite local communication techniques with inherent low probability of interception/low probability of detection (LPI/LPD) characteristics and high frequency reuse for spectrum supportability; investigate use of non-traditional networking methods for high bandwidth needs; design and develop techniques to extend the range of waveforms with propagation limitations and challenges operating through obstruction blockages (e.g. foliage, building, etc.) for line of sight networking; investigate technology with large channel bandwidths that support high data-rate transfer; design and develop mature non-traditional transceiver components for increased capacity, and reduced interference; conduct experiments for high bandwidth, resilient communications for high data rate applications, with improved communications protection between nearby vehicles with LPI/LPD; investigate improved methods to adapt LPI/LPD techniques to mesh networks to counter contested threats in the spectrum environment; mature distributed dismounted beam forming algorithms that enable two distributed beam forming nets to communicate; design and develop an architecture, and related protocols, for secure connection onto existing or third party transport infrastructure; investigate methods to utilize existing networks that will increase available network bandwidth and provide access to resources through a local network topology in which infrastructure nodes cooperatively connect directly, dynamically, and non-hierarchically; begin the design and development of a system that integrates sensor data which is harvested from existing fielded receivers, and propagated across the network to enable improved situational understanding; design and develop components that will help incorporate future radio systems into the sensing architecture; develop data analytics algorithms to identify, evaluate, and correlate specific events from available tactical and intelligence data, leveraging standard protocols and interfaces to current and future tactical receivers with associated visualization and data analytics tools; investigate components for low cost, unattended sensors that can be readily distributed, then discarded, within an area of interest; develop interfaces and methods to use existing tactical radios and receivers; develop small, easily dispersible sensors to deliver large scale sensing over designated areas; develop data consolidation and sampling methods to minimize bandwidth use of large scale sensing devices available through tasking existing receivers.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to 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</p>	4.508	14.705	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602782A / <i>Command, Control, Communications Technology</i>	Project (Number/Name) H92 / <i>Communications Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
AO2 (Stand-In Advanced RF Effects (STARE)), Project AP7(Comms/Horiz Int for Army Mod Priorities Tech), and PE 0602143A (Soldier Lethality Technology) / Project AN1 (Narrowband SATCOM Technology) in FY20 as part of the financial restructuring.				
Title: Defensive Cyber Operations, formerly Cyber/CEMA Operations		7.130	-	-
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.				
Title: Cyber Collaborative Research Alliance (CRA)		2.916	-	-
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.				
Title: Communications, Robust Tactical Systems, formerly Uninterrupted Communications		5.266	15.030	-
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 Satellite Communications (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.				
FY 2019 Plans:				
Design and develop an agile network architecture that globally manages traffic from traditional and non-traditional networks; design and develop algorithms and software to enable resilient controls to support network traffic over Commercial and Government satellite communications (SATCOM) systems; conduct experiments to develop methods for robust narrowband SATCOM with resilience against adversary jamming; research to resilient Mission Command designs that are transport agnostic; investigate and design software-based algorithms for anti-jam, Low Probability of Interception and Deception (LPI/LPD) high frequency communications that incorporate state of the art protection against threat systems and enable operation in a contested environment of High Frequency systems; design and develop a standard interface specification to enable tactical Army units to interoperate with Navy and Air Force components; investigate components for a reliable, long range, and low data rate communications link to provide uninterrupted communications in a contested environment for the Army Tactical network; design a				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602782A / <i>Command, Control, Communications Technology</i>	Project (Number/Name) H92 / <i>Communications Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
<p>proof of concept adaptive system that supports multiple simultaneous radio frequency connections, multiple types of interference cancellation, incorporating diverse paths and waveforms, beam forming, and power control; design and develop a control modem supporting required connectivity, throughput, and protection to support resiliency functions in a contested environment; design and develop a software based adaptive system that supports multiple types of Wideband SATCOM interference mitigation techniques; validate applicability of cognitive reasoning software to recognize interference signals and select the appropriate mitigation techniques and, through machine-learning, grow in responsiveness; conduct experiments to evaluate uninterrupted SATCOM configurations; conduct analysis to determine approach for developing and adding interference cancellation to the Army tactical modems; design and develop algorithms for improved interference rejection and improved jammer stand-off distance to address the tactical Army threats; investigate and design a decoy signal generator of multiple waveforms, capable of deceiving Intelligence, Surveillance, & Reconnaissance (ISR) systems; design and develop obfuscator hardware, supporting sensor and policy-based dynamic spectrum access (DSA) and transmitting obfuscation (flooding) waveforms, and frequency obfuscation to hide troop's radio frequency signatures and spend enemy resources; conduct research to enable extended reach back, data link, and localized communications for long range precision fires; design and develop a single, autonomous and intelligent network across the tactical Army, providing a common user interface and drawing on the available resilient links to maintain data flow; develop solutions to provide reliable voice/data links for the next generation combat vehicles, and tele-operation and data links for Manned/Unmanned-Teaming (MUM-T); develop components to improve resilience of Air-to-Air and Air-to-Ground links for future vertical lift and next generation unmanned aerial system; design algorithms for intelligent networks to enable resilient links and data flow capability for Fire control, sensor data flow, and proximity/distance networking for air and missile defense; validate network-enabled mission command to the dismount soldier through intelligence and situational understanding-based routing of data over resilient communication links.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to 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), and PE 0602143A (Soldier Lethality Technology) / Project AN1 (Narrowband SATCOM Technology) in FY20 as part of the financial restructuring.</p>			
<p>Title: Modular Radio Frequency (RF)</p> <p>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.</p> <p>FY 2019 Plans: Design and develop product architectures based on a Modular Open System Architecture (MOSA) approach that incorporates components of network technologies into a unified solution; identify, validate, and develop standards for major internal interfaces</p>	-	4.800	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602782A / <i>Command, Control, Communications Technology</i>	Project (Number/Name) H92 / <i>Communications Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>and all external interfaces to product components and network capabilities and services; identify, develop, and validate quality attribute requirements that reflect a focus on resilience for autonomous networking to addresses critical product qualities that span a design space of feasible solutions that will allow high value services to maintain persistent network connectivity in congested and contested environments; investigate alternative requirement allocations for different network technology components that will incorporate identified technologies currently in use, and new network technologies, within an agile and resilient autonomous network; develop alternative solutions and validate selection criteria for autonomous networking approaches that provide agile detection and switching among available network connections in order to sustain the network in dense and hostile spectrum environments; investigate situation-adaptive communications to inform networks of current spectrum environment changes (e.g. interference, congestion) for the tactical network links, in an effort to optimize their performance based on available resiliency features, to implement mitigation techniques to maintain operation and inform the automated network of their status and any degradations; investigate the methods for agile networking algorithms to detect network technologies available for inclusion in the automated network processing and determine techniques to minimize user input to establish the detections, authentications, and incorporation of the technologies into the automation.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 062146A (Network C3I Technology) / Project AM6 (Modular RF Communications Technology) in FY20 as part of financial restructuring.</p>				
<p>Title: FY 2019 SBIR / STTR Transfer</p> <p>Description: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 Plans: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer</p>		-	1.020	-
Accomplishments/Planned Programs Subtotals		19.820	35.555	-
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602782A / <i>Command, Control, Communications Technology</i>	Project (Number/Name) H92 / <i>Communications Technology</i>

<u>E. Performance Metrics</u> N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602783A / <i>Computer and Software Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	13.707	14.948	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	28.655
Y10: <i>Computer/Info Sci Tech</i>	-	13.707	14.948	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	28.655

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 (Command, Control and Communications 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.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602783A / <i>Computer and Software Technology</i>
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B. Program Change Summary (\$ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	14.041	14.958	15.235	-	15.235
Current President's Budget	13.707	14.948	0.000	-	0.000
Total Adjustments	-0.334	-0.010	-15.235	-	-15.235
• Congressional General Reductions	-0.007	-0.010			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.327	-			
• Adjustments to Budget Years	-	-	-15.235	-	-15.235

Change Summary Explanation

FY20 decrease related to science and technology financial restructuring..

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602783A / <i>Computer and Software Technology</i>				Project (Number/Name) Y10 / <i>Computer/Info Sci Tech</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Y10: <i>Computer/Info Sci Tech</i>	-	13.707	14.948	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	28.655

Note

In Fiscal Year (FY) 2020 this Project is being 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 Adv 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)

Title: Multi-Media Information Processing and Exploration	FY 2018	FY 2019	FY 2020
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.	1.554	1.863	-
FY 2019 Plans:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602783A / <i>Computer and Software Technology</i>	Project (Number/Name) Y10 / <i>Computer/Info Sci Tech</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>Investigate theoretically grounded approaches for uncertainty quantification and propagation in multi-scale, multi-source data and models; develop methods for computational learning and reasoning that operate on shorter time scales and/or where there may be few or no guarantees of convergence and are amenable to adaptive learning and optimization; and develop self-organizing, self-managing, self-adapting, self-maintaining, self-protecting properties in heterogeneous complex-systems that facilitate interoperability, just-in-time human interactions, and the implementation of local-adaptation functionality in self-organizing, complex human and agent systems.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602146A (Network C3I Technology) / Project AR1 (Robust, Resilient, and Intelligent C3I) Technology) in FY20 as part of the financial restructuring.</p>			
<p>Title: Cyber Security & Information Assurance</p> <p>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.</p> <p>FY 2019 Plans: Explore and implement network and physical layer based approaches for evolving network behavior to improve network resilience in the presence of adversarial disruption based on mission and information requirements; will investigate methods for machine learning (ML) with incomplete information and ambiguous guidance and applications to detect and thwart adversarial ML; investigate generation after next applications for intrusion detection and active defense; investigate applications in threat intelligence as well as attribution of malicious code; investigate identification of malicious activity via network sessions attributes; and will investigate techniques to secure cyber physical systems that do not have integrated security built-in.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602146A (Network C3I Technology) / Project AP3 (Information Assurance and Network Resiliency Techn) in FY20 as part of the financial restructuring.</p>	4.050	4.814	-
<p>Title: Context-Based Information Exchange</p> <p>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.</p> <p>FY 2019 Plans: Develop approaches for adversarial learning that is resilient to continuous learning threats and maximizes Soldier and agent situational awareness; will develop methods and models for complex event processing, with compact representations, efficient pattern evaluation, and mission-centric focus to accelerate reasoning and decision making; and will conduct experiments to</p>	2.334	2.289	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602783A / <i>Computer and Software Technology</i>	Project (Number/Name) Y10 / <i>Computer/Info Sci Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
determine methods that support diverse, nonlinear, and emergent system behaviors or tractable optimization strategies in non-stationary systems. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BF8 (Artificial Intelligence & Machine Learning Tech) in FY20 as part of the financial restructuring.				
Title: Multi-Lingual Computing Description: This effort develops and assesses computational multilingual algorithms and software frameworks to enable commanders and troops to bridge language barriers in order to counter adversaries and collaborate with allies. In FY19, funds from this effort are realigned to support the Army science and technology (S&T) Modernization priorities.		2.597	-	-
Title: Network Theories and Models Description: This effort investigates and designs theory based software models to characterize and validate emerging network protocols and structures. The goal of this effort is to develop software algorithms that maintain effective communications in networks in spite of disruptive effects such as task reorganization, mobility of friendly forces, and adversarial attacks on friendly networks.		1.453	-	-
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. FY 2019 Plans: Investigate computational capabilities and new enabling applications for domain-specific, coupled, and heterogeneous architectures; advance computing capabilities amid fundamental limitations in exponential growth of Moore's law via algorithmic innovations; and develop methods to address planning, reasoning, and uncertainty at the tactical edge enhanced with heterogeneous computing resources. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BF8 (Artificial Intelligence & Machine Learning Tech) in FY20 as part of the financial restructuring.		1.719	1.689	-
Title: Machine Learning with Constrained Resources		-	3.967	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602783A / <i>Computer and Software Technology</i>	Project (Number/Name) Y10 / <i>Computer/Info Sci Tech</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2019 Plans: Develop methods for system-self-awareness of space, time and power characteristics and their relation to requirements of active/pending system missions, with additional ability to degrade or self-destruct gracefully; design approaches that balance the trade-off between accuracy of computation required to answer queries of users, security concerns and mission criticality/relevance; investigate the use of reinforcement learning to develop resilient behaviors and learn effective strategies for accomplishing Soldier relevant mission tasks in complex environments; and develop approaches that learn from human input develop a scalable technique for performing machine learning online, in complex Army environments, and at operational tempo.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BF8 (Artificial Intelligence & Machine Learning Tech) in FY20 as part of the financial restructuring.</p>			
<p>Title: FY 2019 SBIR / STTR Transfer</p> <p>Description: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 Plans: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer</p>	-	0.326	-
Accomplishments/Planned Programs Subtotals	13.707	14.948	-

C. Other Program Funding Summary (\$ in Millions) N/A
Remarks
D. Acquisition Strategy N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602783A / <i>Computer and Software Technology</i>	Project (Number/Name) Y10 / <i>Computer/Info Sci Tech</i>

<u>E. Performance Metrics</u> N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	114.947	101.124	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	216.071
855: <i>Topographical, Image Intel & Space</i>	-	17.603	18.172	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	35.775
H71: <i>Meteorological Research For Battle Command</i>	-	6.599	5.675	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	12.274
T40: <i>Mob/Wpns Eff Tech</i>	-	27.706	32.548	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	60.254
T41: <i>Mil Facilities Eng Tec</i>	-	6.335	7.693	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	14.028
T42: <i>Terrestrial Science Applied Research</i>	-	5.040	5.127	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	10.167
T45: <i>Energy Tec Apl Mil Fac</i>	-	3.464	2.909	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	6.373
T53: <i>Military Engineering Applied Research (CA)</i>	-	48.200	29.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	77.200

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 obscuration 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

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>
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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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	67.720	78.159	80.145	-	80.145
Current President's Budget	114.947	101.124	0.000	-	0.000
Total Adjustments	47.227	22.965	-80.145	-	-80.145
• Congressional General Reductions	-0.020	-0.035			
• Congressional Directed Reductions	-	-6.000			
• Congressional Rescissions	-	-			
• Congressional Adds	48.200	29.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.953	-			
• Adjustments to Budget Years	-	-	-80.145	-	-80.145

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: T53: *Military Engineering Applied Research (CA)*

Congressional Add: *Innovative Construction Materials for the Arctic*

Congressional Add: *Secure Management of Energy Storage*

Congressional Add: *Advanced Blast Load Simulator*

	FY 2018	FY 2019
	8.000	8.000
	3.000	-
	4.500	-

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>
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Congressional Add Details (\$ in Millions, and Includes General Reductions)

	FY 2018	FY 2019
Congressional Add: <i>Construction Materials</i>	7.000	-
Congressional Add: <i>Engineered Resilient Systems</i>	10.000	-
Congressional Add: <i>Lightweight High Performance Materials</i>	10.000	-
Congressional Add: <i>M1 Abrams Tank Track System</i>	1.600	-
Congressional Add: <i>Smart Runway Program</i>	2.100	-
Congressional Add: <i>Bio-inspired Functionally Graded Composites for Hazard Mitigation</i>	2.000	-
Congressional Add: <i>Program Increase: Unspecified</i>	-	5.000
Congressional Add: <i>Cellulose Nanocomposites Research</i>	-	15.000
Congressional Add: <i>Vehicle-born IED Screening</i>	-	1.000
Congressional Add Subtotals for Project: T53	48.200	29.000
Congressional Add Totals for all Projects	48.200	29.000

Change Summary Explanation

FY18 increase related to congressional adds totaling \$48.2 Million.
 FY19 increase related to congressional adds totaling \$29 Million
 FY20 decrease related to science and technology financial restructuring.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>				Project (Number/Name) 855 / <i>Topographical, Image Intel & Space</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
855: <i>Topographical, Image Intel & Space</i>	-	17.603	18.172	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	35.775

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 2018	FY 2019	FY 2020
Title: GeoIntelligence - Geospatial Data Collection, Processing, and Decision Support (Previously titled GeoIntelligence - Geospatial Data Generation and Decision Support)	2.282	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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>	Project (Number/Name) 855 / <i>Topographical, Image Intel & Space</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Environments effort. In addition, the effort investigates advanced models to forecast effects of the physical terrain, human terrain, 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.</p> <p>FY 2019 Plans: Investigate emerging computational models to increase the tempo of small unit tactical decision making through spatial reasoning, analysis, and multi-domain information and data fusion toward narrative information packages aligned with the current mission and situation.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602146A (Network C3I Technologies) / Project AT7 (Network-Enabled GeoSpatial and GEOINT Services Tech) in FY20 as part of the financial restructuring.</p>				
<p>Title: GeoIntelligence - Geospatial Data Analysis and Decision Support</p> <p>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.</p> <p>FY 2019 Plans: Investigate enhanced utility and quality of three-dimensional (3D) imagery for wide area mapping and surveillance of dense urban areas; assess utility and sufficiency of Geiger mode LiDAR prototype for wide area mapping at increasingly higher altitudes and increasing area coverage rates; research emerging remote sensing technologies for a multi-modal, tiered sensing approach to rapidly increase density and quality of 3D urban environment data, merging exterior, interior and below ground geospatial information.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602146A (Network C3I Technologies) / Project AU5 (Automated Analytics for Understanding the Operational Environment Technology) and Project AT9 (Tactical GeoSpatial Information Capabilities Technology) in FY20 as part of the financial restructuring.</p>		4.686	4.923	-
<p>Title: Human Geography - Spatial Reasoning, Analysis, and Visualization</p>		4.060	3.008	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>	Project (Number/Name) 855 / <i>Topographical, Image Intel & Space</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2019 Plans: Develop beta model for estimating future risks and impacts of extreme weather and climate variability on water, energy and food systems to inform the Joint Preparation of the Operational Environment; develop critical enhancements to the suite of methods and tools supporting mission analysis for civil-military operations to enhance stability and mitigate threats to the civilian population.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This effort ends in FY19.</p>			
<p>Title: Weather and Terrain Integration</p> <p>Description: This effort investigates innovative methods for integrating weather and physical terrain applications with geospatial systems compliant with the Army's Common Operating Environment approach to the Army Geospatial Enterprise thereby providing significant advancement to fused all-weather and all-season tactical decision aids supporting risk-based assessments.</p>	2.590	-	-
<p>Title: Map-Based Planning Services (MBPS)</p> <p>Description: This effort develops geospatially-enabled, collaborative mission planning capabilities providing services, data, and information to Army planners, staffs, and leaders. These mission planning capabilities will allow collecting, processing, storing, displaying, and sharing of authoritative data and information in a geo-temporal context. Work will leverage Army Geospatial Enterprise standard data sets and incorporate Geo-Enabled Mission Command tools and analytical capabilities.</p>	3.985	-	-
<p>Title: Geo-enable Computing Environments</p> <p>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.</p> <p>FY 2019 Plans:</p>	-	3.926	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>	Project (Number/Name) 855 / <i>Topographical, Image Intel & Space</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
Investigate a compatible framework for sharing a relevant and focused geospatially enabled visualization of the operational environment within the command post computing environment; investigation focuses on geospatial-enabled collaborative mission planning capabilities providing services, data, and information to the Army planners, staffs, and leadership. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602146A (Network C3I Technology) / Project AU3 (Geospatially Enabled Operational Design Technology) in FY20 as part of the financial restructuring.				
Title: FY 2019 SBIR / STTR Transfer Description: FY 2019 SBIR / STTR Transfer FY 2019 Plans: FY 2019 SBIR / STTR Transfer FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer		-	0.326	-
Accomplishments/Planned Programs Subtotals		17.603	18.172	-
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>				Project (Number/Name) H71 / <i>Meteorological Research For Battle Command</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H71: <i>Meteorological Research For Battle Command</i>	-	6.599	5.675	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	12.274

Note

In Fiscal Year (FY) 2020 this Project is being realigned to:
 Program Element (PE) 0602146A Network C3I Technology:
 * Project AV7 Atmospheric Modeling and Meteorological 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)

Title: Atmospheric Characterization, Modeling, and Impacts (formerly Atmospheric Modeling)	FY 2018	FY 2019	FY 2020
Description: This effort develops high resolution, short-range forecasting, and high resolution atmospheric modeling capabilities for mountainous, urban, and forest complex terrain.	5.593	5.620	-
FY 2019 Plans:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>	Project (Number/Name) H71 / <i>Meteorological Research For Battle Command</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Research and develop decision support technology, including characterizing atmospheric impacts on and optimized paths for hypersonic munitions; research and develop enhancements to automated routing capabilities to include accounting for acoustic signatures of air/ground platforms in varying environments (e.g. complex terrain and dense urban environments); develop and implement methods for decision support tools to ingest and represent probabilistic components and forecast certainty/uncertainty of atmospheric prediction models; develop a densely-instrumented urban environmental testbed to characterize urban flow processes under varied background meteorological conditions; develop system for optimizing Weather Running Estimate-Nowcast (WRE-N) configuration based on geographical characteristics including system verification and validation; optimize the atmospheric boundary layer environment using Lattice Boltzman method (ABLE-LBM) dynamical core for use on small platforms with accelerator cards; demonstrate capability of incorporating unmanned aerial systems (UAS) and other local data sources into a networked- constrained Nowcast model; develop tailored model for improved autonomous system performance; refine of next generation atmospheric acoustic decision support tool used to determine the detection footprint of small UAS by investigating physics constrained machine learning</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602146A (Network C3I Technology) / Project AV7 (Atmospheric Modeling and Meterological Technology) in FY20 as part of the financial restructuring.</p>				
<p>Title: Local Area Atmospheric Prediction for Geospatial Applications (formerly Atmospheric Prediction for Local Areas)</p> <p>Description: This effort designs and determines software models and sensors to improve local characterization and prediction of atmospheric conditions in urban and complex terrain by directly integrating atmospheric boundary layer (the lowest part of the atmosphere in contact with the surface) meteorological measurements into high resolution models and decision aids and validates these improvements with field measurements.</p>		1.006	-	-
<p>Title: FY 2019 SBIR / STTR Transfer</p> <p>Description: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 Plans: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer</p>		-	0.055	-
Accomplishments/Planned Programs Subtotals		6.599	5.675	-
C. Other Program Funding Summary (\$ in Millions)				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>	Project (Number/Name) H71 / <i>Meteorological Research For Battle Command</i>

C. Other Program Funding Summary (\$ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>				Project (Number/Name) T40 / <i>Mob/Wpns Eff Tech</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
T40: <i>Mob/Wpns Eff Tech</i>	-	27.706	32.548	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	60.254

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.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>	Project (Number/Name) T40 / <i>Mob/Wpns Eff Tech</i>
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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 Tank and Automotive Research, Development and Engineering Center (TARDEC) through PE 0603005A (Combat Vehicle and Automotive Advanced Tech) / 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 0604639A (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 0603728 (Environmental Quality Technology Demonstrations) / Project 03E (Environmental Restoration Technology).

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
<p>Title: Adaptive Protection</p> <p>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.</p> <p>FY 2019 Plans: Develop algorithms to predict a range of threat weapon effects on relevant urban construction types and design an assessment tool to ensure safe building occupation decisions; develop and examine rapid signature reduction materials and methods to increase critical asset survivability; develop perimeter security and surveillance technologies and algorithms to detect, track, and classify surface, maritime, and subterranean threat activities; design and develop new protective technologies to defeat future near-peer adversarial threats.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602144A (Ground Technology) / Project BL5 (Expedient Passive Protection for Technology), Project BL9 (Protection from Advanced Weapon Effects Technology), and PE 0602150A (Air and Missile Defense Technology) / Project AE2 (Unconventional Countermeasures-Survivability Tech) in FY20 as part of the financial restructuring.</p>	10.739	13.550	-
<p>Title: Austere Entry and Maneuver</p> <p>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</p>	11.956	13.103	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>	Project (Number/Name) T40 / <i>Mob/Wpns Eff Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>techniques and creates tools to simulate manned/unmanned tactical maneuver and mobility of small disbursed units in complex and urban terrains.</p> <p>FY 2019 Plans: Provide an updated version of a real-time hardware-in-the-loop simulation environment to investigate autonomous vehicle maneuver; develop software to automatically detect mobility obstacles in near-real time; develop algorithms and begin interface design to automate analyses of seismic-infrasound-acoustic-meteorological (SIAM) data for non-subject matter expert use while monitoring infrastructure; identify materials and technologies for modeling efforts to assess and plan projection and protection for dispersed small units in extreme, constantly evolving, and complex environments; begin physics-based modeling efforts to predict projection material performance under repetitive loading during projection operations; identify and examine new materials to reduce weight, increase durability, and enable rapid constructability during force projection and sustainment operations.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602144A (Ground Technology) / Project BL7 (Power Projection in A2/AD Environments Technology), and PE 0602145A (Next Generation Combat Vehicle Technology0 / Project BF1 (Autonomous Ground Resupply Tech) in FY20 as part of the financial restructuring.</p>				
<p>Title: Environmental Impacts on Sensor Performance</p> <p>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.</p> <p>FY 2019 Plans: Develop computational capabilities to investigate unconventional countermeasures to enhance the protection of critical assets; develop new and expand current computational test bed capabilities to simulate dynamic adaptive sensing technologies in emerging threat environments.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement:</p>		3.745	3.862	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>	Project (Number/Name) T40 / <i>Mob/Wpns Eff Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
This research effort was realigned to PE 0602146A (Network C3I Technology) / Project AT2 (Subterranean Detection and Monitoring Technology) and Project AR9 (Persistent Geophysical Sensing and Infrasound Tech) in FY20 as part of the financial restructuring.				
<p>Title: Materials Modeling</p> <p>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.</p> <p>FY 2019 Plans: Provide the first spiral of a virtual material by design procedure to predict engineering properties for force protection material performance; continue laboratory investigations of novel composites, ceramics, polymers, and other non-cementitious materials for layered force protection methods.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602145A (Next Generation Combat Vehicle Technology) / Project BG2 (Modeling & Simulation for MUMT Technology) in FY20 as part of the financial restructuring.</p>		1.266	1.384	-
<p>Title: FY 2019 SBIR / STTR Transfer</p> <p>Description: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 Plans: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer</p>		-	0.649	-
Accomplishments/Planned Programs Subtotals		27.706	32.548	-
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>	Project (Number/Name) T40 / <i>Mob/Wpns Eff Tech</i>

<u>E. Performance Metrics</u> N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>	Project (Number/Name) T41 / <i>Mil Facilities Eng Tec</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
T41: <i>Mil Facilities Eng Tec</i>	-	6.335	7.693	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	14.028

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 2018	FY 2019	FY 2020
Title: Infrastructure for Combat Operations (Previously titled Adaptive and Resilient Installations)	3.692	1.925	-
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.			
FY 2019 Plans:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>	Project (Number/Name) T41 / <i>Mil Facilities Eng Tec</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
Design and develop a prototype decision tool to identify types of additional design scenario variables that relate to the social, cultural, economic and political conditions that impact operational planning; and investigate approaches to fully integrate enterprise business processes and information infrastructure across Army power projection platforms. FY 2019 to FY 2020 Increase/Decrease Statement: Effort ends in FY19.				
Title: Human Geography ? Fundamentals of Behavior and Population Dynamics Description: This effort researches population dynamics including physical, cultural, psychological, and behavioral attributes critical to United States Army engagement activities in an area of operations, including urban environments. Technology development efforts include means to identify dynamic indicators in the socio-cultural realm to assist in estimating or predicting behavioral response to operations and to display indicators in spatial-temporal views for the Warfighter. FY 2019 Plans: Develop a workflow and methodology to incorporate key authoritative Civil Affairs sociocultural datasets into the Army?s military decision making process for informing intelligence preparation of battlefield products for civil considerations and the commander?s critical information requirements; develop a computational framework to integrate multi-scale computational models of environmental, infrastructural, and social systems, enabling information support to the Joint Intelligence Preparation of the Operational Environment (JIPOE) within complex environments. FY 2019 to FY 2020 Increase/Decrease Statement: Effort ends in FY19.		2.643	2.561	-
Title: Robotics for Engineer Operations 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. FY 2019 Plans:		-	2.929	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>	Project (Number/Name) T41 / <i>Mil Facilities Eng Tec</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
Develop robotic construction equipment capabilities allowing Engineers to conduct autonomous and semi-autonomous mobility, countermobility and construction missions. Design proof of concept for a prototype robotic obstacle-removal platform, and develop advanced construction methods for deployed forces. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602144A (Ground Technology) /Project BK7 (Robotics for Engineer Operations Technology) in FY20 as part of the financial restructuring.			
Title: FY 2019 SBIR / STTR Transfer Description: FY 2019 SBIR / STTR Transfer FY 2019 Plans: FY 2019 SBIR / STTR Transfer FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer	-	0.278	-
Accomplishments/Planned Programs Subtotals	6.335	7.693	-

C. Other Program Funding Summary (\$ in Millions)
N/A

Remarks

D. Acquisition Strategy
N/A

E. Performance Metrics
N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>	Project (Number/Name) T42 / <i>Terrestrial Science Applied Research</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>T42: Terrestrial Science Applied Research</i>	-	5.040	5.127	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	10.167

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 2018	FY 2019	FY 2020
Title: Army Terrestrial Environmental Modeling & Intelligence System (ARTEMIS)	3.539	-	-
Description: This effort integrates terrain knowledge and the dynamic effects of weather and mission to provide geospatial reasoning solutions to the Soldier. The understanding gained and products developed improve the ability to predict signature behavior and sensor performance in complex operational environments, improve sensor performance products for tactical decision-making, and improve visualization for mission command. In FY19, funds from this effort are realigned to Geospatial Analytics for High Resolution Enriched Terrain in support of the Army science and technology (S&T) priorities as identified at the December 2016 S&T Army Requirements Oversight Council by the Chief of Staff of the Army.			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>	Project (Number/Name) T42 / <i>Terrestrial Science Applied Research</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Title: GeoIntelligence - Terrestrial Phenomenology Characterization for Geospatial Applications (Previously Titled Analysis for Signal & Signature Phenomenology)</p> <p>Description: This effort investigates the dynamics of electromagnetic, acoustic, and seismic signatures in response to changing terrain state and complex terrain geometry. Research results improve sensor employment tactics, techniques and procedures, and numerical modeling of terrain properties for tactical advantage and geospatial tactical decision aids. In FY19, funds from this effort are realigned to Geospatial Representation of Dynamic Phenomena in support of the Army S&T priorities as identified at the December 2016 S&T Army Requirements Oversight Council by the Chief of Staff of the Army.</p>		1.501	-	-
<p>Title: Tactical Augmented Reality for Operational Technologies - 3D Terrain</p> <p>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.</p> <p>FY 2019 Plans: Develop advanced algorithms for the detection and delineation of edges, sides, and corners of built infrastructure within collected 3D urban data, and export results as light-weight wireframe or mesh to augment the Soldier's situational awareness in dense and congested urban and complex terrain.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602146A (Network C3I Technology) / Project AT9 (Tactical GeoSpatial Information Capabilities Techn) in FY20 as part of the financial restructuring.</p>		-	1.000	-
<p>Title: Geospatial Analytics for High Resolution Enriched Terrain</p> <p>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.</p> <p>FY 2019 Plans:</p>		-	3.000	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>	Project (Number/Name) T42 / <i>Terrestrial Science Applied Research</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
Investigate emerging man/machine learning algorithms to automate production processes, to enable change detection, and to support learning by manned and autonomous systems with the capability to collect and/or complete 3D high-resolution common operating picture of complex and urban terrain. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602146A (Network C3I Technology) / Project AT9 (Tactical GeoSpatial Information Capabilities Techn) in FY20 as part of the financial restructuring.				
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. FY 2019 Plans: Investigate new methods to identify, characterize, track and visualize battlespace objects that change with time (examples include rubble, bridge damage, vehicles, street markets, flooding and other weather induced effects) impacting Soldier and unmanned systems movement and maneuver in complex terrain. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602146A (Network C3I Technology) / Project AT7 (Network-Enabled GeoSpatial and GEOINT Services Tech) in FY20 as part of the financial restructuring.		-	1.127	-
Accomplishments/Planned Programs Subtotals		5.040	5.127	-
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>	Project (Number/Name) T45 / <i>Energy Tec Apl Mil Fac</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
T45: <i>Energy Tec Apl Mil Fac</i>	-	3.464	2.909	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	6.373

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 2018	FY 2019	FY 2020
Title: Infrastructure for Combat Operations (Previously titled Adaptive and Resilient Installations)	3.464	-	-
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.			
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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>	Project (Number/Name) T45 / <i>Energy Tec Apl Mil Fac</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
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.			
<i>FY 2019 Plans:</i> Develop robotic construction capabilities for forward deployed Engineers. This includes autonomous site characterization for construction; debris and obstacle removal; horizontal infrastructure repair; obstacle emplacement; control methodologies for multiple robotic construction equipment to work collaboratively and cooperatively, and additive printing using concrete or other cementitious materials for onsite implementation and use.			
<i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned to PE 0602144A (Ground Technology) /Project BK7 (Robotics for Engineer Operations Technology) in FY20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	3.464	2.909	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>				Project (Number/Name) T53 / <i>Military Engineering Applied Research (CA)</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
T53: <i>Military Engineering Applied Research (CA)</i>	-	48.200	29.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	77.200

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 2018	FY 2019
Congressional Add: Innovative Construction Materials for the Arctic	8.000	8.000
FY 2018 Accomplishments: Innovative Construction Materials for the Arctic		
FY 2019 Plans: Innovative Construction Materials for the Arctic		
Congressional Add: Secure Management of Energy Storage	3.000	-
FY 2018 Accomplishments: Secure Management of Energy Storage		
Congressional Add: Advanced Blast Load Simulator	4.500	-
FY 2018 Accomplishments: Advanced Blast Load Simulator		
Congressional Add: Construction Materials	7.000	-
FY 2018 Accomplishments: Construction Materials		
Congressional Add: Engineered Resilient Systems	10.000	-
FY 2018 Accomplishments: Engineered Resilient Systems		
Congressional Add: Lightweight High Performance Materials	10.000	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / <i>Military Engineering Technology</i>	Project (Number/Name) T53 / <i>Military Engineering Applied Research (CA)</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019
<i>FY 2018 Accomplishments:</i> Lightweight High Performance Materials		
<i>Congressional Add:</i> M1 Abrams Tank Track System	1.600	-
<i>FY 2018 Accomplishments:</i> M1 Abrams Tank Track System		
<i>Congressional Add:</i> Smart Runway Program	2.100	-
<i>FY 2018 Accomplishments:</i> Smart Runway Program		
<i>Congressional Add:</i> Bio-inspired Functionally Graded Composites for Hazard Mitigation	2.000	-
<i>FY 2018 Accomplishments:</i> Bio-inspired Functionally Graded Composites for Hazard Mitigation		
<i>Congressional Add:</i> Program Increase: Unspecified	-	5.000
<i>FY 2019 Plans:</i> Program Increase: Unspecified		
<i>Congressional Add:</i> Cellulose Nanocomposites Research	-	15.000
<i>FY 2019 Plans:</i> Cellulose Nanocomposites Research		
<i>Congressional Add:</i> Vehicle-born IED Screening	-	1.000
<i>FY 2019 Plans:</i> Vehicle-born IED Screening		
Congressional Adds Subtotals	48.200	29.000

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602785A / <i>Manpower/Personnel/Training Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	19.791	21.847	20.873	-	20.873	21.268	19.232	19.159	19.382	0.000	141.552
790: <i>Personnel Performance & Training Technology</i>	-	19.791	21.847	20.873	-	20.873	21.268	19.232	19.159	19.382	0.000	141.552

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 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	20.216	21.862	23.651	-	23.651
Current President's Budget	19.791	21.847	20.873	-	20.873
Total Adjustments	-0.425	-0.015	-2.778	-	-2.778
• Congressional General Reductions	-0.009	-0.015			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.416	-			
• Adjustments to Budget Years	-	-	-2.778	-	-2.778

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602785A / <i>Manpower/Personnel/ Training Technology</i>				Project (Number/Name) 790 / <i>Personnel Performance & Training Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
790: <i>Personnel Performance & Training Technology</i>	-	19.791	21.847	20.873	-	20.873	21.268	19.232	19.159	19.382	0.000	141.552

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 U.S. Army Research Institute (ARI) for the Behavioral and Social Sciences in Fort Belvoir, VA.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Talent Assessment and Development	8.750	12.500	20.873
Description: Conduct applied research that provides the Army with improved prediction and modeling of potential performance, behaviors, attitudes, and resilience of Soldiers, as well as an improved ability to recruit and sustain an effective career force.			
FY 2019 Plans: Conduct research to develop a vocational interest inventory for increased prediction and selection of individual assignments and performance within select critical Military Occupational Specialties (e.g. cyberwarfare); conduct research for the application of non-cognitive measures to inform branching choices for cadets to support sustainment of professional military careers and reduce Soldier attrition costs; conduct research in big data applications to develop automatically generated test items for personnel assessment.			
FY 2020 Plans:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602785A / <i>Manpower/Personnel/ Training Technology</i>	Project (Number/Name) 790 / <i>Personnel Performance & Training Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Will 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; will conduct research to develop outcome measures for more comprehensive assessment of the effectiveness of personnel and training programs/policy; will conduct research to develop methods for assessing and developing complex leader competencies to perform effectively in multi-domain operations (e.g., systems and strategic thinking).</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: In FY 2020, funding in 0602785A/ Project 790 is consolidated into this effort and accelerated in support of Army Modernization efforts.</p>				
<p>Title: Team-Based Personnel Assignment</p> <p>Description: This effort combines and refocuses previous efforts titled "Personnel Performance and Readiness" and "Unit Performance and Cohesion." This effort conducts research to create scientifically valid models, tools and techniques to assign individuals to teams to optimize team effectiveness in-garrison and in future operational environments. Conduct research to create science-based methods to rapidly build team cohesion and collective performance.</p> <p>FY 2019 Plans: Conduct research to develop methods for assessing and developing complex leader competencies to perform effectively in multi-domain operations (e.g., systems and strategic thinking).</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: In FY 2020, funding from this effort is realigned into "Talent Assessment and Development" research effort within Project 790 in support of Army Modernization efforts. .</p>		7.400	3.757	-
<p>Title: Unit Performance and Cohesion</p> <p>Description: This effort was combined in Team-Based Personnel Assignment effort.</p> <p>FY 2019 Plans: Conduct research to develop empirically-validated climate assessments based on objective behaviors (e.g., behavior checklists, unobtrusive measures) that efficiently and accurately assess key aspects of command climate; conduct research to develop methods to assess cohesion in non-traditional teams (e.g., dispersed, diverse, new tasks/missions).</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This effort ends in FY 2019.</p>		3.641	5.100	-
<p>Title: FY 2019 SBIR / STTR Transfer</p>		-	0.490	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602785A / <i>Manpower/Personnel/</i> <i>Training Technology</i>	Project (Number/Name) 790 / <i>Personnel Performance & Training</i> <i>Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
Description: FY 2019 SBIR / STTR Transfer				
FY 2019 Plans: FY 2019 SBIR / STTR Transfer				
FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer				
Accomplishments/Planned Programs Subtotals		19.791	21.847	20.873
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				
E. Performance Metrics				
N/A				

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602786A / <i>Warfighter Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	58.476	56.532	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	115.008
283: <i>Airdrop Adv Tech</i>	-	3.702	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.702
E01: <i>Warfighter Technology Initiatives (CA)</i>	-	20.000	16.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	36.000
H98: <i>Clothing & Equipm Tech</i>	-	26.610	30.364	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	56.974
H99: <i>Joint Service Combat Feeding Technology</i>	-	4.966	4.894	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	9.860
VT4: <i>Expeditionary Mobile Base Camp Technology</i>	-	3.198	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.198
XW5: <i>Small Unit Expeditionary Maneuver Technology</i>	-	0.000	5.274	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.274

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 Initiatives), 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).

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602786A / <i>Warfighter Technology</i>
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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).

B. Program Change Summary (\$ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	39.559	40.566	44.085	-	44.085
Current President's Budget	58.476	56.532	0.000	-	0.000
Total Adjustments	18.917	15.966	-44.085	-	-44.085
• Congressional General Reductions	-0.022	-0.034			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	20.000	16.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.061	-			
• Adjustments to Budget Years	-	-	-44.085	-	-44.085

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: E01: *Warfighter Technology Initiatives (CA)*

Congressional Add: *H98 Clothing and Equipment*

Congressional Add: *Thermal Signature Management Technologies*

Congressional Add: *Expeditionary Mobile Base Camp Technology*

Congressional Add: *Multifunctional advanced lightweight transparent armors*

Congressional Add Subtotals for Project: E01

Congressional Add Totals for all Projects

	FY 2018	FY 2019
	5.000	5.000
	5.000	2.000
	5.000	9.000
	5.000	-
Congressional Add Subtotals for Project: E01	20.000	16.000
Congressional Add Totals for all Projects	20.000	16.000

Change Summary Explanation

FY18 increase related to congressional increases totaling \$20 Million.
 FY19 increase related to congressional increases totaling \$16 Million.
 FY20 decrease related to science and technology financial restructuring.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602786A / Warfighter Technology				Project (Number/Name) 283 / Airdrop Adv Tech			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
283: Airdrop Adv Tech	-	3.702	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.702

Note

In Fiscal Year (FY) 2019 this Project was realigned to 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.

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

Work in this Project is fully coordinated with PE 0603001A (Warfighter Advanced Technology).

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Airdrop/Aerial Delivery Research and Technology	3.702	-	-
Description: This effort investigates technologies that enhance payload extraction, 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 insertion safety and security. This work is coordinated with PE 0603001A (Warfighter Advanced Technology) / Project 242 (Airdrop Equipment) and Project XW6 (Small Unit Expeditionary Maneuver).			
Accomplishments/Planned Programs Subtotals	3.702	-	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army Date: March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602786A / <i>Warfighter Technology</i>	Project (Number/Name) 283 / <i>Airdrop Adv Tech</i>
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D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602786A / Warfighter Technology				Project (Number/Name) E01 / Warfighter Technology Initiatives (CA)			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
E01: Warfighter Technology Initiatives (CA)	-	20.000	16.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	36.000

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Warfighter Technology Applied Research.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019
Congressional Add: H98 Clothing and Equipment	5.000	5.000
FY 2018 Accomplishments: H98 Clothing and Equipment		
FY 2019 Plans: H98 Clothing and Equipment		
Congressional Add: Thermal Signature Management Technologies	5.000	2.000
FY 2018 Accomplishments: Thermal Signature Management Technologies		
FY 2019 Plans: Thermal Signature Management Technologies		
Congressional Add: Expeditionary Mobile Base Camp Technology	5.000	9.000
FY 2018 Accomplishments: Expeditionary Mobile Base Camp Technology		
FY 2019 Plans: Expeditionary Mobile Base Camp Technology		
Congressional Add: Multifunctional advanced lightweight transparent armors	5.000	-
FY 2018 Accomplishments: Multifunctional advanced lightweight transparent armors		
Congressional Adds Subtotals	20.000	16.000

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602786A / Warfighter Technology				Project (Number/Name) H98 / Clothing & Equipm Tech			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H98: <i>Clothing & Equipm Tech</i>	-	26.610	30.364	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	56.974

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 (MUMT) 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 2018	FY 2019	FY 2020
Title: Soldier Blast, Ballistic, and Sensory Protection	12.710	11.272	-
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-			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602786A / <i>Warfighter Technology</i>	Project (Number/Name) H98 / <i>Clothing & Equipm Tech</i>
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B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2019 Plans: Research new technologies for an integrated, single lens that incorporates multiple capabilities into the Soldier vision protection system, including variable transmission lenses with flash protection, laser dazzle and frequency agile pulsed/continuous wave laser protection, and an environmentally- hardened, ballistic fragmentation platform lens with high visual transmission; design and develop cost effective and repeatable laboratory test method that is capable of evaluating the performance of head-borne equipment in a simulated free-field blast overpressure environment; develop research tools to assist the development of a transfer function enabling the scaling of head injury criteria from animal testing to humans to inform future helmet performance requirements based on injury biomechanics; investigate pre-stress and temperature conditioning methods to preserve and/or increase ballistic material mechanical properties during composite laminate processing to enhance ballistic performance; research fundamental understanding of the role of processing-structure-property relationships in ballistic composites, in particular, the role of microstructure on ballistic performance; investigate the penetration mechanics and effectiveness of sphere projectiles against woven armor packages via deconstruction and analysis of individual fabric plies.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project AZ2 (Body Armor & Integrated Headborne Technology), and Project AZ9 (Soldier Protection Advanced Tech - Detectability) in FY20 as part of the financial restructuring.</p>			
<p>Title: Measurement, Prediction, and Improvement of Soldier Performance</p> <p>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.</p>	7.800	8.400	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602786A / <i>Warfighter Technology</i>	Project (Number/Name) H98 / <i>Clothing & Equipm Tech</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p><i>FY 2019 Plans:</i> Design tools to predict Soldier comprehension of information in a dense urban and technology laden terrain by conducting experiments of cognitive function in immersed/simulated environments and then will develop predictive algorithms for decision making at platoon-level operations; investigate and validate human performance metrics for system design in support of emerging situational awareness efficacy of cuing techniques in augmented and mixed reality as well as the intervention of neuro-stimulation to optimize cognitive performance; investigate and validate human performance metrics for system design in support of emerging mobility enhancement to determine the most efficient control scheme and joint augmentation needs of the lower extremity; investigate and validate human performance metrics in support of emerging expeditionary maneuver support by maturing an in vitro gut microbiome model that could deter gastrointestinal distress; design digital humans to inform space claims and human factors engineering considerations for all platforms inhabited or utilized by a Soldier.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned to 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 BB5 (Physical Augmentation: Tech for Human Interactions) in FY20 as part of the financial restructuring.</p>			
<p><i>Title:</i> Advancements in Fibers, Textiles, and Materials for Soldier Protection</p> <p><i>Description:</i> 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.</p> <p><i>FY 2019 Plans:</i> Investigate and develop optical film (VOF) technology for standoff-based signature concealment in a variety of spectral ranges to achieve concealment performance for Soldier uniforms; investigate multifunctional materials suitable for signature management/ decoy and high mobility mission command applications to enable on-demand resupply capabilities; develop novel textile architectures and weaves to provide protection against microwave frequency hazards through reflection and scattering of directed energy threats; investigate the principles of motion versus conspicuity effects on observer perception and apply these principles to simulated real-world operational scenes to evaluate Soldier camouflage; investigate and develop novel sensor systems for measuring heat flux during system and sub-system flame resistance testing to capture the most susceptible burn injury body</p>	6.100	7.400	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602786A / <i>Warfighter Technology</i>	Project (Number/Name) H98 / <i>Clothing & Equipm Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
regions; mature infrared microrectenna arrays to demonstrate wireless power transfer and data communications embedded in the Soldier clothing and individual equipment. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project BB4 (Dismounted Soldier Survivability Materials) in FY20 as part of the financial restructuring.				
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). FY 2019 Plans: Investigate and mature advanced algorithms and sensors for micro and nano robotic systems to enhance autonomy and provide collision avoidance, environmental sensing, and global positioning system (GPS) denied navigation capabilities; investigate novel Soldier-robotic interfaces and interaction modalities to enhance human-machine teaming; investigate micro and nano sensors and robotic platforms, payloads, and architectures to enable Manned-Unmanned Teaming of autonomous systems with dismounted Soldiers. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned PE 0602143A (Soldier Lethality Technology) / Project BD6 (Soldier Sys Interfaces/Integration-Sensor Tech) in FY20 as part of the financial restructuring.		-	2.400	-
Title: FY 2019 SBIR / STTR Transfer Description: FY 2019 SBIR / STTR Transfer FY 2019 Plans: FY 2019 SBIR / STTR Transfer FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer		-	0.892	-
Accomplishments/Planned Programs Subtotals		26.610	30.364	-
C. Other Program Funding Summary (\$ in Millions)				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army Date: March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602786A / <i>Warfighter Technology</i>	Project (Number/Name) H98 / <i>Clothing & Equipm Tech</i>
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C. Other Program Funding Summary (\$ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602786A / <i>Warfighter Technology</i>				Project (Number/Name) H99 / <i>Joint Service Combat Feeding Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
H99: <i>Joint Service Combat Feeding Technology</i>	-	4.966	4.894	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	9.860

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 2018	FY 2019	FY 2020
Title: Joint Combat Feeding Technologies	4.966	4.814	-
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).			
FY 2019 Plans:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602786A / <i>Warfighter Technology</i>	Project (Number/Name) H99 / <i>Joint Service Combat Feeding Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>Study, design, and conduct experiments investigating technologies capable of rapidly detecting adulterated food items prior to consumption, particularly in limited re-supply and austere environments; conduct clinical studies to determine the effect of targeted nutritional strategies on gut and immune health; investigate food processing technologies that increase nutrient retention while meeting shelf life requirements.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / BE3 (Joint Service Combat Feeding Technology) in FY20 as part of the financial restructuring.</p>			
<p>Title: FY 2019 SBIR / STTR Transfer</p> <p>Description: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 Plans: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer</p>	-	0.080	-
Accomplishments/Planned Programs Subtotals	4.966	4.894	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602786A / <i>Warfighter Technology</i>				Project (Number/Name) VT4 / <i>Expeditionary Mobile Base Camp Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
VT4: <i>Expeditionary Mobile Base Camp Technology</i>	-	3.198	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.198

Note

In Fiscal Year (FY) 2019 this Project was realigned to:
 Program Element (PE) 0602786A Soldier Lethality Technology
 * Project XW5 Small Unit Expeditionary Maneuver Technology

A. Mission Description and Budget Item Justification

This Project matures and validates fully integrated holistic expeditionary base camp (EBC) capabilities with mission-specific plug and play components, subsystems, and modules designed to optimize manpower requirements, enhance situational awareness, increase Soldier readiness and survivability, optimize habitation, reduce logistics footprint, enhance supportability, and reduce cost. EBC systems provide an operational capability for small combat units (battalion and below) and Soldiers in varying environments, which are rapidly deployable and re-locatable, require no Military Construction, and need limited materiel handing support. This Project matures technologies that can be combined to create mission specific lab demonstrators and develops metrics and methodologies to measure performance characteristics.

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 fully coordinated with Program Element (PE) 0602784A (Military Engineering Technology) and 0603734A (Military Engineering Advanced Technology), PE 0603001A (Warfighter Advanced Technology), PE 0603004A (Weapons and Munitions Advanced Technology), PE 0603005A (Combat Vehicle and Automotive Advanced Technology), PE 0603125A (Combating Terrorism Technology Development), and PE 0603772A (Advanced Tactical Computer Science and Sensor Technology).

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Expeditionary Base Camp Component Technologies	FY 2018	FY 2019	FY 2020
Description: This effort investigates base camp component interoperability and matures and scales component technologies for an integrated holistic base camp concept. This effort supports the basing sustainment and logistics capability investigation. This work is coordinated with PE 0603001A (Warfighter Advanced Technology) / Project VT5 (Expeditionary Mobile Base Camp Demonstration), Project XW6 (Small Unit Expeditionary Maneuver), PE 0602786A (Warfighter Technology) / Project H99 (Joint Service Combat Feeding Technology) and is coordinated with PE 0602784A (Military Engineering Technology) / Project T40 (Mob/Wpns Eff Tech), PE 0603734A (Military Engineering Advanced Technology) / Project T08 (Combat Eng Systems), PE 0603004A (Weapons and Munitions Advanced Technology) / Project L97 (Smoke And Obscurants Advanced Technology), PE 0603005A (Combat Vehicle and Automotive Advanced Technology) / Project 497 (Combat Vehicle Electro), PE 0603125A (Combating Terrorism - Technology Development) / Project DF5 (Agile Integration & Demonstration), and PE 0603772A	3.198	-	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602786A / <i>Warfighter Technology</i>	Project (Number/Name) VT4 / <i>Expeditionary Mobile Base Camp Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
(Advanced Tactical Computer Science and Sensor Technology) / Project 101 (Tactical Command and Control). In FY19, work in this Project realigns into Project XW5 Small Unit Expeditionary Maneuver Tech, along with Project 283 Airdrop Adv Tech and Project H99 Joint Service Combat Feeding Technology.			
Accomplishments/Planned Programs Subtotals	3.198	-	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602786A / <i>Warfighter Technology</i>	Project (Number/Name) <i>XW5 / Small Unit Expeditionary Maneuver Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>XW5: Small Unit Expeditionary Maneuver Technology</i>	-	0.000	5.274	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.274

Note

In FY20 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) in FY19 to create an integrated expeditionary maneuver research focus area.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
<p>Title: Aerial Delivery</p> <p>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.</p> <p>FY 2019 Plans: Study, design, and conduct experiments with precision aerial delivery software and hardware components to enhance precision aerial delivery capabilities and assure re-supply via manned and unmanned systems in A2/AD environments; conduct research</p>	-	3.681	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602786A / <i>Warfighter Technology</i>	Project (Number/Name) XW5 / <i>Small Unit Expeditionary Maneuver Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
in the area of maneuver assistance in personnel airdrop systems to accelerate the certification of airborne jumpers from novice to master jumper. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project BE3 (Joint Service Combat Feeding Technology) and Project BE1 (Support Technology to Mission Command) in FY20 as part of the financial restructuring.				
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 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. FY 2019 Plans: Study, design, and conduct experiments that investigate autonomous deployment methodologies, additive manufacturing of components used in expeditionary maneuver platforms that support expeditionary operations in all environments, and concepts for rapidly-deployable platforms that allows for integration of technologies that will improve protection and minimize resource consumption. FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602143A (Soldier Lethality Technology) / Project BE3 (Joint Service Combat Feeding Technology) and Project BE1 (Support Technology to Mission Command) in FY20 as part of the financial restructuring.		-	1.500	-
Title: FY 2019 SBIR / STTR Transfer Description: FY 2019 SBIR / STTR Transfer FY 2019 Plans: FY 2019 SBIR / STTR Transfer FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer		-	0.093	-
Accomplishments/Planned Programs Subtotals		-	5.274	-
C. Other Program Funding Summary (\$ in Millions)				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602786A / <i>Warfighter Technology</i>	Project (Number/Name) <i>XW5 / Small Unit Expeditionary Maneuver Technology</i>

C. Other Program Funding Summary (\$ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: Research, Development, Test & Evaluation, Army / BA 2: Applied Research	R-1 Program Element (Number/Name) PE 0602787A / Medical Technology
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
Total Program Element	-	88.891	92.003	99.155	-	99.155	94.786	93.903	94.955	96.392	0.000	660.085
869: Warfighter Health Prot & Perf Stnds	-	39.254	35.754	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	75.008
870: Dod Med Def Ag Inf Dis	-	21.928	21.638	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	43.566
874: Cbt Casualty Care Tech	-	12.232	12.769	0.869	-	0.869	0.000	0.000	0.000	0.000	0.000	25.870
ET4: Appl Resch in Clinical and Rehabilitative Medicine	-	7.557	12.123	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	19.680
MK4: Warfigher Health Applied Rsch Technology	-	0.000	0.000	38.392	-	38.392	37.911	38.028	39.275	40.001	0.000	193.607
MM4: Cbt Casualty Care Applied Rsch Technology	-	0.000	0.000	17.909	-	17.909	18.092	19.100	19.431	19.626	0.000	94.158
MM6: Medical Technologies to Support Dispersed Ops Tech	-	0.000	0.000	12.109	-	12.109	13.575	12.058	13.961	14.081	0.000	65.784
MM8: Infectious Diseases and Applied Rsch Technology	-	0.000	0.000	21.661	-	21.661	18.241	17.892	18.543	18.887	0.000	95.224
MN1: Applied Sensory Systems Trauma Technology	-	0.000	0.000	7.615	-	7.615	6.967	6.825	3.745	3.797	0.000	28.949
VB3: MEDICAL TECHNOLOGY INITIATIVES (CA)	-	6.000	2.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	8.000
VB4: System Biology And Network Science Technology	-	1.920	2.006	0.600	-	0.600	0.000	0.000	0.000	0.000	0.000	4.526
XV5: Medical Capabilities to Support Dispersed Ops	-	0.000	5.713	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.713

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.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>
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A. Mission Description and Budget Item Justification

This 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 five 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.

Project 869 Warfighter Health Prot & Perf Stnds

Description: Refines knowledge and technologies on screening tools and preventive measures for post-traumatic stress disorder (PTSD) and 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. Also conducts research on medically valid testing devices (i.e., the test mannequins that are true to the human form and physiologically and anatomically accurate) and predictive models used for the refinement of Warfighter protective equipment. This Project is being coordinated with the Defense Health Agency.

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. This Project is being coordinated with the Defense Health Agency.

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 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. This Project is being 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. This Project is coordinated with the Defense Health Agency.

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 SysBioCube (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 and visualization within the SysBioCube to inform the

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	
<p>development of prognostic indicators, objective diagnostics, and improved and personalized therapeutic strategies more quickly than non-systems approaches. The SBCC also serves as a Medical Research Materiel Command (MRMC) resource for data sharing and data management for maximizing the value of all research efforts across the Command.</p> <p>Project XV5 Medical Capabilities to Support Dispersed Ops Description: Research to 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.</p> <p>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.</p> <p>Project MM4 Cbt Casualty Care Applied Rsch 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.</p> <p>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.</p> <p>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.</p> <p>The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering Science and Technology, focus areas and the Army Modernization Strategy.</p> <p>Work in this PE is performed by the United States Army Medical Research Materiel Command (USAMRMC), Fort Detrick, MD.</p>		

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Exhibit R-2, RDT&E Budget Item Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040: <i>Research, Development, Test & Evaluation, Army / BA 2: Applied Research</i>	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>
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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 Defense (DoD) biomedical research and refinement community, as well as their associated enabling research areas.

B. Program Change Summary (\$ in Millions)	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total
Previous President's Budget	83.434	90.075	94.708	-	94.708
Current President's Budget	88.891	92.003	99.155	-	99.155
Total Adjustments	5.457	1.928	4.447	-	4.447
• Congressional General Reductions	-0.039	-0.072			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	6.000	2.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	1.413	-			
• SBIR/STTR Transfer	-1.917	-			
• Adjustments to Budget Years	-	-	4.447	-	4.447

Congressional Add Details (\$ in Millions, and Includes General Reductions)

Project: VB3: *MEDICAL TECHNOLOGY INITIATIVES (CA)*

Congressional Add: *Burn Patient Transfer System*

Congressional Add: *Program Increase*

Congressional Add Subtotals for Project: VB3

Congressional Add Totals for all Projects

	FY 2018	FY 2019
	2.000	2.000
	4.000	-
Congressional Add Subtotals for Project: VB3	6.000	2.000
Congressional Add Totals for all Projects	6.000	2.000

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602787A / Medical Technology				Project (Number/Name) 869 / Warfighter Health Prot & Perf Stnds			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
869: Warfighter Health Prot & Perf Stnds	-	39.254	35.754	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	75.008

Note

In Fiscal Year (FY) 2020, 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) Environmental Health and Protection
- (2) Physiological Health and Performance
- (3) Injury Prevention and Reduction
- (4) Psychological Health and Resilience

Additionally, the Warfighter Systems Engineering Architecture task advances medical science and technology in the areas of injury prevention and performance sustainment in the context of human interaction with new Soldier systems, and provides greater insight into informing new research in developing Warfighter systems and the interactions between Warfighters and the systems they employ.

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 Materiel Command (USAMRMC), Fort Detrick, MD.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Physiological Health - Nutritional Sustainment and Fatigue Interventions	4.584	-	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) 869 / <i>Warfighter Health Prot & Perf Stnds</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
Description: This effort evaluates methods for managing and controlling the effects of fatigue on Warfighter operational performance and the impact of nutritional strategies to optimize operational performance.				
Title: Physiological Health and Performance		-	5.173	-
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.				
FY 2019 Plans: Develop nutritional interventions for resistance to stress (environmental/physical/cognitive) in the field. Evaluate individual differences of environmental influences on Soldier eating behavior. Improve the health of muscle and bone through characterization of protein source effects on metabolic kinetics. Develop a military-specific eating questionnaire for evaluation of nutritional approaches to resist military stress. Conduct studies to determine the effectiveness of energy and/or protein supplementation for preventing declines in lean body mass and cognition during and after caloric deficit. Continue to develop a descriptive model outlining factors linking the central nervous system and other organs/systems that impact resilience. Investigate physiological aspects of human health and performance optimization and enhancement.				
FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602787A (Medical Technology) / MK4 (Warfighter Health Applied Rsch Technology) in FY20 as part of the financial restructuring.				
Title: Concussion/Mild Traumatic Brain Injury (mTBI) Interventions		2.207	-	-
Description: This effort refines and evaluates methods to detect and treat concussion as well as identify and evaluate the effects of cognitive deficits (decreases in the ability of individuals to acquire knowledge and understanding through thought experience and the senses) and risk factors for spinal injury in military vehicle occupants during operations.				
Title: Environmental Health and Protection - Physiological (human physical and biochemical functions) Awareness Tools and Warrior Sustainment in Extreme Environments		1.285	-	-
Description: This effort evaluates the combined impact of extreme temperatures, humidity, and altitude on human health and performance and determines novel mitigation strategies to enhance tolerance, sustain performance, and protect the Warfighter against environmental injury. This effort provides evidence-based practice recommendations, biomarkers of adaptation, and models for protecting health and performance against combinations of environmental threats.				
Title: Environmental Health and Protection		-	7.949	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) 869 / <i>Warfighter Health Prot & Perf Stnds</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2019 Plans: Determine the combined impact of heat, humidity, and high altitude on human health and performance. Quantify Heat Tolerance Test specificity to include the effects of heat acclimation on the prediction of heat illness susceptibility and return to duty guidelines. Quantify how physiological adaptations and acquired thermal tolerance to heat stress protect against acute mountain sickness susceptibility as well as physical and cognitive performance at high altitude. Develop new technologies that enable quantitative measurements at a point-in-time during training and operational activities. Increase dexterity performance in cold environments by combining facial and forearm microclimate heating interventions. Develop computational models of individualized Soldier health, readiness, and physiological performance.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602787A (Medical Technology) / MK4 (Warfighter Health Applied Rsch Technology) in FY20 as part of the financial restructuring.</p>			
<p>Title: Biomarkers of Exposure and Environmental Biomonitoring (measurement of the body's response to toxic chemical compounds, elements, or their metabolites, in biological substances)</p> <p>Description: This effort supports refinement and evaluation of methods to detect exposure to environmental contaminants and toxic chemicals during military operations. This effort develops an integrated experimental and computational platform to characterize host responses to environmental hazards in terms of pathogenic (disease causing) and adaptive processes, yielding mechanistically based drug targets and molecular diagnostics.</p>	4.794	-	-
<p>Title: Injury Prevention and Reduction - Neurosensory Injury Prevention</p> <p>Description: This area includes research efforts to develop 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, develop and evaluate neurosensory operational risk factors, develop medically based guidelines to assess neurosensory performance and model the effects of acoustic and impact trauma, as stressors on vision and hearing.</p>	4.657	-	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) 869 / <i>Warfighter Health Prot & Perf Stnds</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Title: Injury Prevention and Reduction - Musculoskeletal Injury Prevention</p> <p>Description: This effort 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 Warfighters following injury.</p>		3.153	-	-
<p>Title: Injury Prevention and Reduction</p> <p>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.</p> <p>FY 2019 Plans: Develop injury criteria for the prevention of acute and chronic cervical neck injury and pain that will guide the development of helmets and technologies added to the helmet. Develop mTBI injury thresholds for repetitive blast exposure that can guide the development of head protection. Refine physical performance thresholds for potential improvements to the Occupational Physical Assessment Test (OPAT) which will improve how well recruits are screened to do Department of Defense (DoD) relevant physically demanding tasks. Develop countermeasures to reduce the risk of overuse injury within the training and operational environment. Identify cognitive and sensory performance metrics associated with optimal MUM-T and identify physiological and behavioral fitness for duty metrics to operate in MUM-T paradigms. Develop medical standards and health hazard assessment algorithms for exposure to directed energy threats.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602787A (Medical Technology) / MK4 (Warfighter Health Applied Rsch Technology) in FY20 as part of the financial restructuring.</p>		-	7.484	-
<p>Title: Psychological Health - Psychological Resilience</p>		8.315	-	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) 869 / <i>Warfighter Health Prot & Perf Stnds</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>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, post-concussive symptoms, and other health risk behaviors. Also assesses and refines tools and interventions to enhance and sustain psychological resilience throughout the Warfighter's career.</p>				
<p>Title: Psychological Health & Resilience - Suicide Prevention</p> <p>Description: This effort supports methods to identify and modify causative and preventive factors in military suicides.</p>		4.778	-	-
<p>Title: Psychological Health and Resilience</p> <p>Description: This effort refines and evaluates early interventions to prevent and reduce combat-related behavioral health problems, including symptoms of 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.</p> <p>FY 2019 Plans: Assess risk and resilience markers (e.g., moral injury) for male and female Soldiers' psychological and behavioral health; determine the optimal dosing of Attention Bias Modification Training, a computerized treatment that reduces anxiety. Evaluate 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. Assess key high-risk emotional and behavioral transition points, develop a non-contact screening tool and other interventions to decrease suicide behaviors. Adapt and evaluate a diet formulated with a balanced omega-3/6 fatty acid ratio, glutamine, and antioxidants in an animal model for pilot study in humans in order to provide neuroprotection against military stressors. Develop molecular pharmacological approaches and novel compounds to mitigate the adverse behavioral effects of traumatic stress. Continue studies focused upon identification of PTSD subtypes, stage of disease progression, and development of associated biomarkers in order to develop a precision medicine approach to PTSD treatment. Initiate studies for enhancing behavioral health treatment engagement, improving provider clinical support tools for return-to-duty decisions and identifying dissemination models for optimal behavioral health provider education.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602787A (Medical Technology) / MK4 (Warfighter Health Applied Rsch Technology) in FY20 as part of the financial restructuring.</p>		-	14.403	-
<p>Title: Millennium Cohort Research</p> <p>Description: This effort supports a long-term study of Warfighters that includes psychological and physical impacts of military service throughout their lifetime. The Millennium Cohort and Deployment Health Task area employs prospective epidemiological</p>		4.583	-	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) 869 / <i>Warfighter Health Prot & Perf Stnds</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
(study of health-event patterns in a society) surveillance research designed to address mental health and comorbid (multiple concurrent) disorders, including neurological and other chronic degenerative disorders, fitness and readiness performance outcomes, and longer-term physical and mental health illnesses and disease over the life cycle of military Service Members.			
Title: Soldier Systems Engineering Architecture Description: This effort will advance medical science in the areas of injury prevention to optimize and sustain performance. This effort develops bio- mathematical models and networked physiological sensor systems that accurately predict metabolic cost, thermal strain and other negative health impacts to the Warfighter during physical challenges, i.e., during load carriage or operating in extreme environments.	0.898	-	-
Title: FY2019 SBIR / STTR Transfer Description: FY 2019 SBIR / STTR Transfer FY 2019 Plans: FY 2019 SBIR / STTR Transfer FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer	-	0.745	-
Accomplishments/Planned Programs Subtotals	39.254	35.754	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602787A / Medical Technology				Project (Number/Name) 870 / Dod Med Def Ag Inf Dis			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
870: Dod Med Def Ag Inf Dis	-	21.928	21.638	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	43.566

Note

In Fiscal Year (FY) 2020, 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 new biotechnologies into the refinement of new concepts for new vaccine, drug, and diagnostics 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.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) 870 / <i>Dod Med Def Ag Inf Dis</i>
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Work is managed by the United States Army Medical Research and Materiel Command (USAMRMC) 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 2018	FY 2019	FY 2020
<p>Title: Applied Research on drugs and vaccines against parasitic diseases</p> <p>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.</p> <p>FY 2019 Plans: 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 FDA to enable oral dosing studies in humans. 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. Complete laboratory based analyses of human immune cells from Plasmodium falciparum malaria vaccine trials to enable down selection of a lead vaccine for transition to advanced development. Conduct initial effectiveness trials of potential lead vaccine formulations in primate models of a relapsing malaria, Plasmodium vivax.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602787A (Medical Technology) / MM8 (Infectious Diseases and Applied Rsch Technology) in FY20 as part of the financial restructuring.</p>	11.826	9.856	-
<p>Title: Diagnostic Systems and Vector Identification and Control</p> <p>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.).</p> <p>FY 2019 Plans:</p>	1.362	0.514	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) 870 / <i>Dod Med Def Ag Inf Dis</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
Further develop and evaluate the capability for fabrics treated with repellants to protect or resist against biting insects and other arthropod vectors. Continue to evaluate multiplexed pathogen detection systems (capable of detecting multiple pathogens at the same time) to screen for priority emerging or re-emerging pathogens. FY 2019 to FY 2020 Increase/Decrease Statement: Research effort ends in FY19.				
Title: Viral Threats Research Description: This effort designs and laboratory tests new vaccine candidates 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. FY 2019 Plans: Sustain field sites as part of ongoing research partner efforts in testing dengue vaccine immunogenicity (ability to provoke an immune response) and effectiveness. Conduct immune cell and antibody assessments in human subjects exposed to dengue by dengue human infection model. Conduct immune cell and antibody assessments in human subjects immunized with purified inactivated virus and live attenuated virus vaccines. 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 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602787A (Medical Technology) / MM8 (Infectious Diseases and Applied Rsch Technology) in FY20 as part of the financial restructuring.		3.243	4.755	-
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), wound infection and scrub typhus (a debilitating mite-borne disease). FY 2019 Plans: Continue to develop and advance additional vaccine candidates against Shigella, Campylobacter and enterotoxigenic E. coli (ETEC). Continue to down select vaccine candidates for testing in animal models of diarrhea caused by Shigella, Campylobacter and ETEC. Perform an assessment of multivalent (different types) vaccine candidates for Shigella and ETEC in animal models of diarrhea. Produce vaccine candidates for testing in humans using Good Manufacturing Processes. Continue to evaluate the		5.497	6.065	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army	Date: March 2019
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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) 870 / <i>Dod Med Def Ag Inf Dis</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
feasibility of clinical field sites for the assessment of vaccine candidates in humans. Continue to maintain the animal model for scrub typhus infection and will continue studies on characterization of host-pathogen interactions in these animal models. <i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned to PE 0602787A (Medical Technology) / MM8 (Infectious Diseases and Applied Rsch Technology) in FY20 as part of the financial restructuring.			
<i>Title:</i> FY 2019 SBIR / STTR Transfer <i>Description:</i> FY 2019 SBIR / STTR Transfer <i>FY 2019 Plans:</i> FY 2019 SBIR / STTR Transfer <i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> FY 2019 SBIR / STTR Transfer	-	0.448	-
Accomplishments/Planned Programs Subtotals	21.928	21.638	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>				Project (Number/Name) 874 / <i>Cbt Casualty Care Tech</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>874: Cbt Casualty Care Tech</i>	-	12.232	12.769	0.869	-	0.869	0.000	0.000	0.000	0.000	0.000	25.870

Note

In Fiscal Year (FY) 2020, this Project is being realigned to:
 Program Element (PE) 0602787A Medical Technology
 * 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.

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 United States Army Medical Research Materiel Command (USAMRMC), Fort Detrick, MD.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Damage Control Resuscitation	5.335	3.442	-
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 2019 Plans:			
Begin study of new techniques to control bleeding using catheters or other devices that are introduced into damaged blood vessels. Conduct studies of new hemostatic (stops bleeding) dressings to determine if they may be safely left in place on wounds to control bleeding for extended periods of time. Start a new research focus area on endovascular (refers to device that is directly introduced into a major blood vessel) hemorrhage control and resuscitation. Continue studies to optimize performance metrics and assays of stem cells for treatment of trauma- or infection-induced impairment of blood clotting ability. Continue development of			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) 874 / <i>Cbt Casualty Care Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>new technologies for early assessment of blood clot strength. Continue work to investigate drugs and blood products to optimize treatment of impaired blood clotting and destabilized tissues due to traumatic bleeding.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602787A (Medical Technology) / Project MM4 (Cbt Casualty Care Applied Rsch Technology) in FY20 as part of the financial restructuring.</p>				
<p>Title: Combat Trauma Therapies</p> <p>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.</p> <p>FY 2019 Plans: Conduct animal studies to assess adverse effects of inflammation factors released in response to blast injury. Examine potential treatments to mitigate adverse effects of hemorrhage resuscitation on severe extremity wounds. Evaluate stem cell therapy and drugs to promote healing in severe extremity injuries. Continue development and testing of combined agents (containing agents to kill bacteria, prevent bacteria from becoming infective, and to control inflammation) to treat contaminated facial, mouth and extremity wounds.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602787A (Medical Technology) / Project MM4 (Cbt Casualty Care Applied Rsch Technology) in FY20 as part of the financial restructuring.</p>		3.482	2.232	0.869
<p>Title: Combat Critical Care Engineering</p> <p>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.</p> <p>FY 2019 Plans: Conduct animal studies to determine whether currently used pain-relieving drugs produce detrimental cardiovascular effects during hemorrhage resuscitation. Study use of different stem cell products in animal models of lung injury. Will develop a small animal model of acute kidney injury caused by cessation of kidney blood flow due to severe, prolonged blood loss in which to assess new agents that protect the blood-deprived kidney. Determine the whole-body effects of tourniquet release after prolonged use. Design an automated, closed-loop burn and trauma resuscitation system that continuously monitors the patient's condition</p>		1.433	3.399	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) 874 / <i>Cbt Casualty Care Tech</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
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and automatically executes, without human intervention, an immediate and appropriate therapeutic response whenever the patient's condition deviates from normal. Examine the ability of different critical care treatment algorithms to accurately detect and diagnose changes in patient condition and elicit an appropriate therapeutic response. Develop and evaluate new technologies that will enable combat medics to provide basic critical care in out-of-hospital settings when medical evacuation is either delayed or prolonged. Continue work to mitigate risk of blood clot formation within the tubing of external life support devices (devices that oxygenate and purify the blood outside of the body) while at the same time allow normal blood clotting to occur in the patient. Continue work to assess physiological responses to airway compromise and to test new airway management techniques.

FY 2019 to FY 2020 Increase/Decrease Statement:
This research effort was realigned to PE 0602787A (Medical Technology) / Project MM4 (Cbt Casualty Care Applied Rsch Technology) in FY20 as part of the financial restructuring.

Title: Traumatic Brain Injury	1.982	1.650	-
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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 traumatic brain injury (TBI) resulting from battlefield trauma.

FY 2019 Plans:
Evaluate mild TBI treatment strategies using animal models. Evaluate potential stem cell therapies in a severe TBI animal model. Complete development of large animal models of TBI and TBI-polytrauma (TBI in combination with severe bleeding and lung and other vital organ injuries). Perform studies to determine which biomarkers effectively indicate whether a particular therapy works and recovery is occurring.

FY 2019 to FY 2020 Increase/Decrease Statement:
This research effort was realigned to PE 0602787A (Medical Technology) / Project MM4 (Cbt Casualty Care Applied Rsch Technology) in FY20 as part of the financial restructuring.

Title: Prolonged Field Care	-	1.680	-
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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 2019 Plans:
This effort begins in FY19, planned accomplishments include development and testing of animal models of prolonged care for life-threatening extremity injuries and combat casualty injuries leading to kidney failure.

FY 2019 to FY 2020 Increase/Decrease Statement:

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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) 874 / <i>Cbt Casualty Care Tech</i>
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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
This research effort was realigned to PE 0602787A (Medical Technology) / Project MM4 (Cbt Casualty Care Applied Rsch Technology) in FY20 as part of the financial restructuring.			
Title: FY 2019 SBIR / STTR Transfer	-	0.366	-
Description: FY 2019 SBIR / STTR Transfer			
FY 2019 Plans: FY 2019 SBIR / STTR Transfer			
FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer			
Accomplishments/Planned Programs Subtotals	12.232	12.769	0.869

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>				Project (Number/Name) ET4 / <i>Appl Resch in Clinical and Rehabilitative Medicine</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
ET4: <i>Appl Resch in Clinical and Rehabilitative Medicine</i>	-	7.557	12.123	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	19.680

Note

In Fiscal Year (FY) 2020, 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. This Project is being coordinated with the Defense Health Program. 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 and other government organizations to avoid duplication. Research conducted in this Project focuses on Clinical and Rehabilitative Medicine.

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 Materiel Command (USAMRMC), Fort Detrick, MD.

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Clinical and Rehabilitative Medicine	FY 2018	FY 2019	FY 2020
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.	7.557	9.092	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) ET4 / <i>Appl Resch in Clinical and Rehabilitative Medicine</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>FY 2019 Plans: Continue to optimize the preclinical design of a novel ocular medical device designed to deliver therapeutics, protect, and preserve vision post-injury. Advance evaluations of stem-cell based therapies to regenerate damaged eye tissues into pre-clinical animal testing. Utilize intra-eye large animal drug delivery system to deliver and evaluate effectiveness of nerve therapeutics to preserve and regenerate injured optic nerves. Continue to conduct pre-clinical safety and effectiveness testing of an eye bandage with therapeutics to optimize vision restoration post-injury. Continue to develop and evaluate methods for enhancing skin substitute performance for improvement of skin function following burns and loss from trauma. Continue the examination of pharmacologic (drug) treatments to prevent scarring from deep partial-thickness burns. Examine the effectiveness of treatment methodologies for large volume muscle loss to restore muscle form and function. Continue to develop devices and biologics for regeneration or restoration of genitourinary (genital and urinary) tissues lost or damaged due to traumatic injury.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602787A (Medical Technology) / Project MN1 (Applied Sensory Systems Trauma Technology) in FY20 as part of the financial restructuring.</p>				
<p>Title: Battlefield Pain Management</p> <p>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.</p> <p>FY 2019 Plans: Conduct animal studies to investigate the role of ion channel receptors and pain signaling; will develop peripheral nerve or antagonist analgesics to preserve the fighting force and maximize pain relief from combat wounds in austere and prolonged care environments while minimizing adverse side effects such as tolerance, dependence and chronification (occasional/intermittent pain that progresses to a chronic state) of acute pain.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602787A (Medical Technology) / Project MN1 (Applied Sensory Systems Trauma Technology) in FY20 as part of the financial restructuring.</p>		-	2.599	-
<p>Title: FY 2019 SBIR / STTR Transfer</p> <p>Description: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 Plans: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement:</p>		-	0.432	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) ET4 / <i>Appl Resch in Clinical and Rehabilitative Medicine</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
FY 2019 SBIR / STTR Transfer			
Accomplishments/Planned Programs Subtotals	7.557	12.123	-

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>				Project (Number/Name) MK4 / <i>Warfighter Health Applied Rsch Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
MK4: <i>Warfighter Health Applied Rsch Technology</i>	-	0.000	0.000	38.392	-	38.392	37.911	38.028	39.275	40.001	0.000	193.607

Note

In Fiscal Year (FY) 2020, 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; 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) Environmental Health and Protection
- (2) Physiological Health and Performance
- (3) Injury Prevention and Reduction
- (4) Psychological Health and Resilience

Additionally, the Warfighter Systems Engineering Architecture task advances medical science and technology (S&T) in the areas of injury prevention and performance sustainment in the context of human interaction with new Soldier systems, and provides greater insight into informing new research in developing Warfighter systems and the interactions between Warfighters and the systems they employ.

Promising efforts identified in this project are further matured under PE 0603002A (Medical Advanced Technology) / Project MG4 (Tech Base/Enabling Research in Military Occupation), Project MN6 (Blast & Head Impact Exposure Monitor Advanced Tech), Project MN7 Musculoskeletal Injury Screening Tool Adv Tech, Project MN9 Far Forward Behavioral Health Care Advanced Tech, Project MO3 Military Occupational Fitness Standards Adv Tech, Project MO8 Expeditionary Performance Nutrition Advanced Tech, and Project MP3 Phys Chem Toxicity Assessment Sys 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 Materiel Command (USAMRMC), Fort Detrick, MD.

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019	
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) MK4 / <i>Warfighter Health Applied Rsch Technology</i>	
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019
<p>Title: Physiological Health and Performance</p> <p>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 investments in human biomedical performance enhancement and medical aspects of manned-unmanned machine teaming (MUM-T).</p> <p>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 Soldier 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602787A (Medical Technology) / Project 869 (Warfighter Health Prot & Perf Stnds) in FY20 as part of the financial restructuring.</p> <p>In FY20, increased funding for Physiological Health & Performance is due to normal and planned progression of existing efforts in the high priority of program efforts in sleep, nutrition and human performance. Significant increases in funding are due to new investments in high-priority areas of biomedical performance enhancement of Soldier physiological, cognitive and psychological capabilities as well as medical aspects of MUM-T.</p>		-	-
<p>Title: Environmental Health and Protection</p> <p>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</p>		-	-
		17.125	6.129

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) MK4 / <i>Warfighter Health Applied Rsch Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602787A (Medical Technology) / Project 869 (Warfighter Health Prot & Perf Stnds) in FY20 as part of the financial restructuring.</p>				
<p>Title: Injury Prevention and Reduction</p> <p>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 MUM-T and medical aspects of and protection against directed energy.</p> <p>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</p>		-	-	7.428

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) MK4 / <i>Warfighter Health Applied Rsch Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602787A (Medical Technology) / Project 869 (Warfighter Health Prot & Perf Stnds) in FY20 as part of the financial restructuring.</p> <p>Title: Psychological Health and Resilience</p> <p>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.</p> <p>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 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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602787A (Medical Technology) / Project 869 (Warfighter Health Prot & Perf Stnds) in FY20 as part of the financial restructuring.</p>		-	-	7.710
Accomplishments/Planned Programs Subtotals		-	-	38.392
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) MK4 / <i>Warfighter Health Applied Rsch Technology</i>

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>				Project (Number/Name) MM4 / <i>Cbt Casualty Care Applied Rsch Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
MM4: <i>Cbt Casualty Care Applied Rsch Technology</i>	-	0.000	0.000	17.909	-	17.909	18.092	19.100	19.431	19.626	0.000	94.158

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, as well as treatment under austere field conditions. 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 burns, and traumatic injuries to hard and soft tissues of the face, mouth, and extremities and traumatic brain injury (TBI).

Promising efforts identified in this Project are further matured under PE 0603002A (Medical Advanced Technology) / Project MM5 (Tech Base/Enabling Res Combat Cas Care Adv Tech).

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 Materiel Command (USAMRMC), Fort Detrick, MD.

B. Accomplishments/Planned Programs (\$ in Millions)

Title: Damage Control Resuscitation	FY 2018	FY 2019	FY 2020
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.	-	-	3.961
FY 2020 Plans:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) MM4 / <i>Cbt Casualty Care Applied Rsch Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602787A (Medical Technology) / Project 874 (Cbt Casualty Care Tech) in FY20 as part of the financial restructuring.</p>				
<p>Title: Combat Trauma Therapies</p> <p>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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602787A (Medical Technology) / Project 874 (Cbt Casualty Care Tech) in FY20 as part of the financial restructuring.</p>		-	-	4.310
<p>Title: Pre-Hospital Tactical Combat Casualty Care</p> <p>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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement:</p>		-	-	0.910

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) MM4 / <i>Cbt Casualty Care Applied Rsch Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
This research effort was realigned from PE 0602787A (Medical Technology) / Project 874 (Cbt Casualty Care Tech) in FY20 as part of the financial restructuring.				
<p>Title: Traumatic Brain Injury (TBI)</p> <p>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.</p> <p>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).</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602787A (Medical Technology) / Project 874 (Cbt Casualty Care Tech) in FY20 as part of the financial restructuring.</p>		-	-	1.404
<p>Title: Prolonged Field Care</p> <p>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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602787A (Medical Technology) / Project 874 (Cbt Casualty Care Tech) in FY20 as part of the financial restructuring.</p>		-	-	7.324
Accomplishments/Planned Programs Subtotals		-	-	17.909

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) MM4 / <i>Cbt Casualty Care Applied Rsch Technology</i>
C. Other Program Funding Summary (\$ in Millions) N/A		
Remarks		
D. Acquisition Strategy N/A		
E. Performance Metrics N/A		

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>				Project (Number/Name) MM6 / <i>Medical Technologies to Support Dispersed Ops Tech</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
MM6: <i>Medical Technologies to Support Dispersed Ops Tech</i>	-	0.000	0.000	12.109	-	12.109	13.575	12.058	13.961	14.081	0.000	65.784

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 will focus on the delivery of healthcare and class VIII by ground or air in dispersed and multi-domain battle environments. Will enable 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. This project supports 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 Materiel Command (USAMRMC), Fort Detrick, MD.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Medical Robotic and Autonomous Systems (Med-RAS)	-	-	8.033
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 Battle 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 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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) MM6 / <i>Medical Technologies to Support Dispersed Ops Tech</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602787A (Medical Technology) / Project XV5 (Medical Capabilities to Support Dispersed Ops) in FY20 as part of the financial restructuring.</p>				
<p>Title: Virtual Health</p> <p>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.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602787A (Medical Technology) / Project XV5 (Medical Capabilities to Support Dispersed Ops) in FY20 as part of the financial restructuring.</p>		-	-	4.076
Accomplishments/Planned Programs Subtotals		-	-	12.109
C. Other Program Funding Summary (\$ in Millions)				
N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) MM6 / <i>Medical Technologies to Support Dispersed Ops Tech</i>

C. Other Program Funding Summary (\$ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>				Project (Number/Name) MM8 / <i>Infectious Diseases and Applied Rsch Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
MM8: <i>Infectious Diseases and Applied Rsch Technology</i>	-	0.000	0.000	21.661	-	21.661	18.241	17.892	18.543	18.887	0.000	95.224

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

Applied research to design and refine drugs, vaccines, other medical countermeasures against naturally occurring infectious diseases as identified by worldwide medical surveillance and capability needs assessments.

Promising medical countermeasures identified in this Project are further matured under PE 0603002A (Medical Advanced Technology) / Project MM9 (Tech Base/ Enabling Rsrch for Infect Dis Adv Tech), Project MN8 (Drugs to Prevent and Treat Malaria Advanced Tech), and Project MO9 (Vaccines to Prevent Dengue Fever Advanced Tech).

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 Materiel Command (USAMRMC) 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 2018	FY 2019	FY 2020
Title: Applied research on drugs and vaccines against parasitic diseases	-	-	10.123
Description: Identify and optimize lead drug compounds to identify candidates for human studies. Test lead drug candidates for safety and toxicity in animals. Down-select lead candidates as a malaria drug for use in humans. Optimize antigens and platforms for use in animal studies. Evaluate new vaccine candidates for safety, effectiveness, and immunogenicity in animal models to advance to human clinical trials.			
FY 2020 Plans: 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			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) MM8 / <i>Infectious Diseases and Applied Rsch Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602787A (Medical Technology) / Project 870 (DoD Med Def Ag Inf Did) as part of the financial restructuring.</p>			
<p>Title: Viral Threats Research</p> <p>Description: Optimize vaccine components and platforms for use in animal studies. Evaluate new vaccine candidates against dengue and Hantaviruses for safety, and immunogenicity in animal models to advance to human clinical trials.</p> <p>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.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned from PE 0602787A (Medical Technology) / Project 870 (DoD Med Def Ag Inf Did) as part of the financial restructuring.</p>	-	-	5.666
<p>Title: Bacterial Threats</p> <p>Description: Optimize antigens and platforms for use in animal studies. Evaluate bacterial diarrheal vaccine candidates for safety, effectiveness, 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.</p> <p>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</p>	-	-	5.872

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) MM8 / <i>Infectious Diseases and Applied Rsch Technology</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
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.				
<i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602787A (Medical Technology) / Project 870 (DoD Med Def Ag Inf Did) as part of the financial restructuring.				
Accomplishments/Planned Programs Subtotals		-	-	21.661
C. Other Program Funding Summary (\$ in Millions) N/A				
Remarks				
D. Acquisition Strategy N/A				
E. Performance Metrics N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) MN1 / <i>Applied Sensory Systems Trauma Technology</i>
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
<i>MN1: Applied Sensory Systems Trauma Technology</i>	-	0.000	0.000	7.615	-	7.615	6.967	6.825	3.745	3.797	0.000	28.949

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 MN2 Tech/Enabling Research for Sensory Systems 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 Materiel Command (USAMRMC), Fort Detrick, MD.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Applied Sensory Systems Trauma Technology	-	-	7.615
Description: Applied research on the treatment of severe injuries to sensory systems. Design, develop, and improve technologies to deliver therapeutics, protect, and preserve vision following severe eye trauma; early evaluation of stem-cell therapies to regenerate damaged eye tissues; and early evaluation of nerve therapeutics to preserve or regenerate the optic nerve. Research to understand the influence of stress on the effectiveness of pain relief drugs (analgesics).			
FY 2020 Plans:			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) MN1 / <i>Applied Sensory Systems Trauma Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
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. <i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> This research effort was realigned from PE 0602787A (Medical Technology) / Project ET4 (Appl Resch in Clinical and Rehabilitative Medicine) in FY20 as part of the financial restructuring.			
Accomplishments/Planned Programs Subtotals	-	-	7.615

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>				Project (Number/Name) VB3 / <i>MEDICAL TECHNOLOGY INITIATIVES (CA)</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
VB3: <i>MEDICAL TECHNOLOGY INITIATIVES (CA)</i>	-	6.000	2.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	8.000

A. Mission Description and Budget Item Justification

Congressional Interest Item for Medical Technology applied research.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019
<i>Congressional Add:</i> Burn Patient Transfer System	2.000	2.000
<i>FY 2018 Accomplishments:</i> Burn Patient Transfer System		
<i>FY 2019 Plans:</i> Burn Patient Transfer System		
<i>Congressional Add:</i> Program Increase	4.000	-
<i>FY 2018 Accomplishments:</i> Program Increase		
Congressional Adds Subtotals	6.000	2.000

C. Other Program Funding Summary (\$ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army										Date: March 2019		
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>				Project (Number/Name) VB4 / <i>System Biology And Network Science Technology</i>			
COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
VB4: <i>System Biology And Network Science Technology</i>	-	1.920	2.006	0.600	-	0.600	0.000	0.000	0.000	0.000	0.000	4.526

A. Mission Description and Budget Item Justification

This Project supports biological and clinical applied research using the data analysis and integration grid (SysBioCube) 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 as seen in biomarker development for Post-Traumatic Stress Disorder (PTSD) and enhanced analyses of coagulopathy. Another application of systems biology is to characterize physiological pathways altered by toxic substances enabling identification of the causative toxic substances as well as to understand the injury mechanisms. The detection/identification of physiological markers of exposure to toxic substances can then be used to support medical countermeasure decisions or development of targeted therapeutic drugs.

These examples of more complex, yet integrated approaches to Projects studying biological systems have been shown to reduce both the time and expense of medical product development for the Army.

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 Materiel Command (USAMRMC), Fort Detrick, MD.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Systems Biology	1.920	1.942	0.600
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 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.			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) VB4 / <i>System Biology And Network Science Technology</i>

B. Accomplishments/Planned Programs (\$ in Millions)	FY 2018	FY 2019	FY 2020
<p><i>FY 2019 Plans:</i> Expand Systems Biology capabilities through collaborative intramural and extramural partnerships, and accommodate an expected increase in the number of end-users of the SysBioCube. Expand the data repository capability within the SysBioCube. Continue to oversee data sharing and data integration of large, complex datasets. Continue to increase capabilities to develop novel methods that integrate different systems biology data (e.g., genetics, microbiome, and metabolism data) that, in turn, will lead to new knowledge products. Continue to provide support to the Integrative Systems Biology Program at USACEHR for oversight of research efforts. Continue development of SysBioCube capabilities and functions such as integration and harmonization of additional data types (variant level Next Generation Sequencing data), browse and filtering functions to search for and sort specific assay types and associated data, tracking of assays conducted, and additional tools for longitudinal analysis and visualization of integrated data. Use time-dependent clinical data collections and integrated omics (omics refers to the collective technologies used to explore the roles, relationships, and actions of the various types of molecules that make up the cells of an organism) analyses of treatment efficacies to support a wide range of research efforts that will include additional biomarker development and understanding of the underlying altered molecular mechanisms of a) PTSD (including changes in the microbiome (gut microbes) and in metabolism) that will begin to correlate co-morbid (concurrent) conditions, and b) infectious diseases.</p> <p><i>FY 2020 Plans:</i> Will complete all studies under this effort.</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> Remaining funding is to close out this effort.</p>			
<p><i>Title:</i> FY 2019 SBIR / STTR Transfer</p> <p><i>Description:</i> FY 2019 SBIR / STTR Transfer</p> <p><i>FY 2019 Plans:</i> FY 2019 SBIR / STTR Transfer</p> <p><i>FY 2019 to FY 2020 Increase/Decrease Statement:</i> FY 2019 SBIR / STTR Transfer</p>	-	0.064	-
Accomplishments/Planned Programs Subtotals	1.920	2.006	0.600

C. Other Program Funding Summary (\$ in Millions) N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) VB4 / <i>System Biology And Network Science Technology</i>

C. Other Program Funding Summary (\$ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army **Date:** March 2019

Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / Medical Technology	Project (Number/Name) XV5 / Medical Capabilities to Support Dispersed Ops
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COST (\$ in Millions)	Prior Years	FY 2018	FY 2019	FY 2020 Base	FY 2020 OCO	FY 2020 Total	FY 2021	FY 2022	FY 2023	FY 2024	Cost To Complete	Total Cost
XV5: Medical Capabilities to Support Dispersed Ops	-	0.000	5.713	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.713

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 line will support the following three new medical task areas: 1) Autonomous and Unmanned medical capability - will focus on developing the ability to use platforms to perform evacuations and deliver emergency resupply of Class VIII medical supplies, such as blood products, by ground or air, 2) Virtual Health - will enable prolonged care and deciding faster by exploiting emerging communications and information technology for remote telemonitoring and telementoring, 3) Medical Aspects of man- machine teaming - will enable 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.

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 Materiel Command (USAMRMC), Fort Detrick, MD.

B. Accomplishments/Planned Programs (\$ in Millions)

	FY 2018	FY 2019	FY 2020
Title: Medical Robotic and Autonomous Systems (Med-RAS)	-	1.648	-
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 Battle concept and the Army Force 2025 and Beyond vision.			
FY 2019 Plans: Utilize invasive and non-invasive sensor systems to define new models for human physiologic responses to injury. Data from these models will be used to define new algorithms that drive resuscitation and critical care procedures in animal models. Define algorithms for implementation across a full spectrum of automation capabilities. Define the physiological process associated with injury in trauma simulations that would be amenable to automated therapeutics with autonomous medical systems. Explore			

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) <i>XV5 / Medical Capabilities to Support Dispersed Ops</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>feasibility of integrating medical capabilities and information systems with Army unmanned systems (UMS) Programs of Record in order to leverage multipurpose robotic platforms for medical capabilities. Research standardization of medical device interfaces for use in an autonomous platform. Research feasibility of Unmanned Aerial Systems (UAS) to support remote patient monitoring research prototypes, closed-loop patient support systems, and prototype automated diagnostic and therapeutic en route care capabilities.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602787A (Medical Technology) / Project MM6 (Medical Technologies to Support Dispersed Ops Tech) in FY20 as part of the financial restructuring.</p>				
<p>Title: Virtual Health</p> <p>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.</p> <p>FY 2019 Plans: Generate an overall virtual health technology research plan with detailed research tasks to support the multi-domain battlefield concept to include potential cross-domain with other research task areas. Research and model novel virtual health enterprise process architectures to provide new intersections of health information and knowledge far forward to support the multi-domain battlefield concept. Conduct a gap analysis of mechanisms for virtual health secure data transmission and communications in the tactical environment leveraging novel means to reduce virtual health encounter data packet sizes through novel compression algorithms to facilitate use in very limited communication scenarios to support the multi-domain battlefield concept. Determine key physiological constructs that are predictive of health status and readiness for development of a micro-footprint biosensor-based assessment tools.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602787A (Medical Technology) / Project MM6 (Medical Technologies to Support Dispersed Ops Tech) in FY20 as part of the financial restructuring.</p>		-	1.928	-
<p>Title: Medical Aspects of Man-Machine Teaming/Medical Robotics</p> <p>Description: Research, design, and prototype 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 Battle concept and the Army Force 2025 and Beyond vision.</p> <p>FY 2019 Plans: Research the design of robotic systems, including physical interfaces and hardware configurations, to effectively implement and control resuscitation and critical care procedures driven by algorithms defined by complementary research described in the</p>		-	1.928	-

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Exhibit R-2A, RDT&E Project Justification: PB 2020 Army		Date: March 2019		
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / <i>Medical Technology</i>	Project (Number/Name) <i>XV5 / Medical Capabilities to Support Dispersed Ops</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2018	FY 2019	FY 2020
<p>Autonomous and Unmanned Medical Capability Task Area. Research and design a proof of concept field robotic fold-up litter to show the feasibility of deploying soft robotics sensors and also show the capability to apply pressure using a soft robotics manipulator. Model and characterize the problems caused by signal latency and constrained bandwidth on complex tele-robotic surgical tasks. Research and prioritize procedures amenable to full automation of tele-robotic operations. Research and explore the feasibility of using robotic perception systems to detect casualties from a standoff distance and at closer ranges using both conventional computer vision approaches and recent advancements in deep learning techniques. Will research and prioritize procedures.</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: This research effort was realigned to PE 0602787A (Medical Technology) / Project MM6 (Medical Technologies to Support Dispersed Ops Tech) in FY20 as part of the financial restructuring.</p>				
<p>Title: FY 2019 SBIR / STTR Transfer</p> <p>Description: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 Plans: FY 2019 SBIR / STTR Transfer</p> <p>FY 2019 to FY 2020 Increase/Decrease Statement: FY 2019 SBIR / STTR Transfer</p>		-	0.209	-
Accomplishments/Planned Programs Subtotals		-	5.713	-
C. Other Program Funding Summary (\$ in Millions)				
N/A				
Remarks				
D. Acquisition Strategy				
N/A				
E. Performance Metrics				
N/A				