Department of Defense
Fiscal Year (FY) 2018 Budget Estimates

May 2017

Army

Justification Book of

Research, Development, Test & Evaluation, Army

RDT&E − Volume I, Budget Activity 2

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, $9,544,808,000 to remain available for obligation until September 30, 2019.

The following Justification Books were prepared at a cost of $250,916: Aircraft (ACFT), Missile (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 2018 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 2018.

2. **Relationship of the FY 2018 Budget Submitted to Congress to the FY 2017 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.

A. New Start Programs:

Budget Activity	OSDPE/Project	Project Title
01	0601104A/FF5	Distributed Collaborative Intelligent Systems CTA
01	0601104A/FF7	Internet of Battlefield Things CTA
03	0603001A/FF6	Individual Protection
03	0603009A/FH1	Tractor Hike
04	0603639A/XT5	30mm Anti-Personnel and Counter-Air
04	0603645A/EV7	Combat Vehicle Prototyping
04	0603807A/VS7	MEDEVAC Mission Equipment Package (MEP) - Adv Dev
04	0604017A/FD2	Soldier Robotics Systems
04	0604017A/FD3	Battery Modernization & Interface Standardization
04	0604017A/FD9	Robotics Systems

Budget Activity	OSDPE/Project	Project Title
04	0604117A/FI4	Maneuver – Short Range Air Defense (M-SHORAD)
04	0604120A/EJ3	ANTI-JAM ANTENNA
04	0604121A/FD6	Synthetic Training Environment Refine & Prototype
05	0604601A/FF2	Small Arms Fire Control
05	0604601A/FI2	Lightweight 30mm Cannon
05	0604604A/H07	Family Of Med Tac Veh
05	0604768A/688	ATACMS BLK II
05	0604768A/P01	MULTI - MODE SEEKER DEVELOPMENT AND TEST
05	0604802A/EW1	40mm LV High Explosive Air Burst, XM1166
05	0604802A/FA6	30mm Lethality
05	0604804A/FG4	Ultra-Lightweight Camouflage Net System (ULCANS)
05	0604818A/ER9	Expeditionary Army Command Post
05	0604823A/L87	Hypervelocity Projectile System
05	0604852A/FE8	Vehicle Protection Suite
05	0605013A/VR3	ASMIS-R (REPORTIT)
05	0605037A/EQ6	Evidence Collection and Detainee Processing
05	0605053A/FB2	Man Transportable Robotic System (MTRS) Inc II
05	0605053A/FB3	Robotics Architecture
05	0605053A/FB4	Common Robotic Systems
05	0605053A/FB6	Squad Multipurpose Equipment Transport (SMET)
05	0605053A/FB7	Robotics Enhanced Program (REP)
05	0605053A/FB8	Soldier Borne Sensor (SBS)

Budget Activity	**OSDPE/Project**	**Project Title**
05	0605053A/FB9	MTRS Standardization
05	1205117A/FG3	Tractor Bears
06	0606001A/FD4	Military Ground-Based CREW Technology
07	0203735A/280	RECOV VEH IMPROV PROG
07	0203735A/431	M113 IMPROVEMENTS
07	0203743A/FF9	PIM Improvement Program
07	0203802A/788	ATACMS PIP
07	0205412A/EE6	Environmental Information Tech Modernization
07	0303028A/FG2	Counterintelligence & Human Intel Modernization
07	0303140A/FF8	Unit Activity Monitoring (UAM)
07	0305172A/XT9	Combined Advanced Applications

B. Program Element/Project Restructures:

Budget Activity	Old OSDPE/Project: Title	New OSDPE/Project: Title
04	0603308A/990: Space and Missile Defense Integration	1206308A/FE5: Space and Missile Defense Integration
04	0603308A/EB7: Army Space System Enhancement/Integration	1206308A/FE6: Army Space System Enhancement/Integration
04	0305219AMQ1: MQ-1 Gray Eagle – Army UAV (MIP)	0603804A/EW8: Armored Engineer Vehicles
05	0604201A/VU3: Networking and Mission Planning	0604201A/EW7: Degraded Visual Environment
05	0603639A/EB8: OWL for Small Caliber Ammunition	0604802A/EP4: One-Way Luminescence For Small Caliber Ammo
05	0603639A/EU2: Improved Multi-Option Fuze (iMOFA/iMOFM)	0604802A/EU8: Improved Multi-Option Fuze
05	0604827A/S65: Platoon Power Generator	0604827A/EY2: Integrated Soldier Power Data System Core
05	0604827A/S65: Platoon Power Generator	0604827A/EY4: Universal Battery Charger
05	0203735A/EE2: Stryker Improvement	0604852A/XU9: Active Protection System
05	0605013A/738: AcqBiz	0605013A/FE9: ALTESS (P & R Forms)
05	0603627A/E79: Smoke/Obscurant System	0605038A/EQ7: NBC Reconnaissance Vehicle (NBCRV)
05	0605051A/ER8: Common Missile Warning System (CMWS)	0605049A/XT4: Advanced Threat Detection System (ATDS)
05	0303142A/EA3: Transportable Tactical Cmd Comms (T2C2)	0605766A/EX7: Air Vigilance System Development
06	0605898A/M03: Command HQ - MRDC	0605898A/XW7: Command HQ - ARI
06	0605301A/DX2: Army Kwajalein and Mission Support	0606002A/XW9: Reagan Test Site
07	0303142A/253: Dscs-Dcs (Phase II)	1203142A/FE1: Dscs-Dcs (Phase II)
07	0303142A/456: MILSATCOM System Engineering	1203142A/FE2: MILSATCOM System Engineering
07	0303142A/EA3: Transportable Tactical Cmd Comms (T2C2)	1203142A/FE4: Enroute Mission Command
07	0208053A/635: Joint Tact Grd Station P3I (MIP)	1208053A/FE7: Joint Tact Grd Station-P3I(MIP)
07	0305219A/RQ7: RQ-7 Shadow UAV	0607143A/EX1: Unmanned Aircraft Systems Universal Products

C. Program Terminations:

Budget Activity	OSDPE/Project	OSDPE Title/Project Title
01	0601104A/H53	University & Industry Rsch Ctrs / Army High Performance Computing Research Center
01	0601104A/H53	University & Industry Rsch Ctrs / Micro-autonomous Systems Technology (MAST) CTA
05	0604601A/S62	Infantry Support Weapons / Counter-Defilade Target Engagement - SDD

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 2018 President's Budget Request
Exhibit R-1 FY 2018 President's Budget Request
Total Obligational Authority
(Dollars in Thousands)

26 Apr 2017

Appropriation	FY 2016 Base + OCO	FY 2017 PB Request with CR Adj Base	FY 2017 Total PB Requests* with CR Adj Base	FY 2017 PB Request with CR Adj OCO	FY 2017 Total PB Requests* with CR Adj OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj OCO
Research, Development, Test & Eval, Army	7,861,744	7,547,794	7,897,415	1,500	233,300	-78,700	154,600
Total Research, Development, Test & Evaluation	7,861,744	7,547,794	7,897,415	1,500	233,300	-78,700	154,600

Department of Defense
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26 Apr 2017

Appropriation	FY 2017 Total PB Requests** with CR Adj Base+OCO+SAA	FY 2017 Total PB Requests* with CR Adj Base + OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj Base + OCO	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Research, Development, Test & Eval, Army	7,627,994	8,130,715	-78,700	8,052,015	9,425,440	119,368	9,544,808
Total Research, Development, Test & Evaluation	7,627,994	8,130,715	-78,700	8,052,015	9,425,440	119,368	9,544,808

R-1C1F: FY 2018 President's Budget Request (Published Version), as of April 26, 2017 at 08:46:19

Department of Defense
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(Dollars in Thousands)

26 Apr 2017

Summary Recap of Budget Activities	FY 2016 Base + OCO	FY 2017 PB Request with CR Adj Base	FY 2017 Total PB Requests* with CR Adj Base	FY 2017 PB Request with CR Adj OCO	FY 2017 Total PB Requests* with CR Adj OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj OCO
Basic Research	450,831	428,943	428,943				
Applied Research	1,070,349	907,574	907,574				
Advanced Technology Development	1,113,746	930,065	943,365				
Advanced Component Development & Prototypes	499,287	550,635	566,835	9,375	25,395		25,395
System Development & Demonstration	2,202,652	2,265,094	2,393,383	84,043	288,443	-78,700	209,743
RDT&E Management Support	1,259,926	1,136,134	1,161,991				
Operational Systems Development	1,264,953	1,296,954	1,462,929	7,104	18,484		18,484
Undistributed		32,395	32,395	-99,022	-99,022		-99,022
Total Research, Development, Test & Evaluation	7,861,744	7,547,794	7,897,415	1,500	233,300	-78,700	154,600
Summary Recap of FYDP Programs							
General Purpose Forces	802,086	618,038	697,138		4,530		4,530
Intelligence and Communications	400,329	238,711	268,755	7,104	8,854		8,854
Research and Development	6,596,225	6,591,738	6,832,215	93,418	318,938	-78,700	240,238
Central Supply and Maintenance	58,503	62,287	62,287				
Administration and Associated Activities	65	32,395	32,395	-99,022	-99,022		-99,022
Space							
Classified Programs	4,536	4,625	4,625				
Total Research, Development, Test & Evaluation	7,861,744	7,547,794	7,897,415	1,500	233,300	-78,700	154,600

Department of Defense
FY 2018 President's Budget Request
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26 Apr 2017

Summary Recap of Budget Activities	FY 2017 Total PB Requests** with CR Adj Base+OCO+SAA	FY 2017 Total PB Requests* with CR Adj Base + OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj Base + OCO	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Basic Research	428,943	428,943		428,943	430,022		430,022
Applied Research	907,574	907,574		907,574	889,182		889,182
Advanced Technology Development	930,065	943,365		943,365	1,070,977		1,070,977
Advanced Component Development & Prototypes	560,010	592,230		592,230	890,889	18,000	908,889
System Development & Demonstration	2,427,837	2,681,826	-78,700	2,603,126	3,012,840	57,840	3,070,680
RDT&E Management Support	1,136,134	1,161,991		1,161,991	1,253,845		1,253,845
Operational Systems Development	1,304,058	1,481,413		1,481,413	1,877,685	43,528	1,921,213
Undistributed	-66,627	-66,627		-66,627			
Total Research, Development, Test & Evaluation	7,627,994	8,130,715	-78,700	8,052,015	9,425,440	119,368	9,544,808
Summary Recap of FYDP Programs							
General Purpose Forces	618,038	701,668		701,668	710,401	15,000	725,401
Intelligence and Communications	245,815	277,609		277,609	370,519	29,728	400,247
Research and Development	6,763,856	7,151,153	-78,700	7,072,453	8,215,942	74,640	8,290,582
Central Supply and Maintenance	62,287	62,287		62,287	60,877		60,877
Administration and Associated Activities	-66,627	-66,627		-66,627			
Space					60,547		60,547
Classified Programs	4,625	4,625		4,625	7,154		7,154
Total Research, Development, Test & Evaluation	7,627,994	8,130,715	-78,700	8,052,015	9,425,440	119,368	9,544,808

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Basic Research	450,831	428,943	428,943				
Applied Research	1,070,349	907,574	907,574				
Advanced Technology Development	1,113,746	930,065	943,365				
Advanced Component Development & Prototypes	499,287	550,635	566,835	9,375	25,395		25,395
System Development & Demonstration	2,202,652	2,265,094	2,393,383	84,043	288,443	-78,700	209,743
RDT&E Management Support	1,259,926	1,136,134	1,161,991				
Operational Systems Development	1,264,953	1,296,954	1,462,929	7,104	18,484		18,484
Undistributed		32,395	32,395	-99,022	-99,022		-99,022
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Research and Development	6,596,225	6,591,738	6,832,215	93,418	318,938	-78,700	240,238
Central Supply and Maintenance	58,503	62,287	62,287				
Administration and Associated Activities	65	32,395	32,395	-99,022	-99,022		-99,022
Space							
Classified Programs	4,536	4,625	4,625				
Total Research, Development, Test & Evaluation	7,861,744	7,547,794	7,897,415	1,500	233,300	-78,700	154,600

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Basic Research	428,943	428,943		428,943	430,022		430,022
Applied Research	907,574	907,574		907,574	889,182		889,182
Advanced Technology Development	930,065	943,365		943,365	1,070,977		1,070,977
Advanced Component Development & Prototypes	560,010	592,230		592,230	890,889	18,000	908,889
System Development & Demonstration	2,427,837	2,681,826	-78,700	2,603,126	3,012,840	57,840	3,070,680
RDT&E Management Support	1,136,134	1,161,991		1,161,991	1,253,845		1,253,845
Operational Systems Development	1,304,058	1,481,413		1,481,413	1,877,685	43,528	1,921,213
Undistributed	-66,627	-66,627		-66,627			
Total Research, Development, Test & Evaluation	7,627,994	8,130,715	-78,700	8,052,015	9,425,440	119,368	9,544,808
Summary Recap of FYDP Programs							
General Purpose Forces	618,038	701,668		701,668	710,401	15,000	725,401
Intelligence and Communications	245,815	277,609		277,609	370,519	29,728	400,247
Research and Development	6,763,856	7,151,153	-78,700	7,072,453	8,215,942	74,640	8,290,582
Central Supply and Maintenance	62,287	62,287		62,287	60,877		60,877
Administration and Associated Activities	-66,627	-66,627		-66,627			
Space					60,547		60,547
Classified Programs	4,625	4,625		4,625	7,154		7,154
Total Research, Development, Test & Evaluation	7,627,994	8,130,715	-78,700	8,052,015	9,425,440	119,368	9,544,808

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

Line No	Program Element Number	Item	Act	FY 2016 Base + OCO	FY 2017 PB Request with CR Adj Base	FY 2017 Total PB Requests* with CR Adj Base	FY 2017 PB Request with CR Adj OCO	FY 2017 Total PB Requests* with CR Adj OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj OCO	Sec
1	0601101A	In-House Laboratory Independent Research	01	12,525	12,381	12,381					U
2	0601102A	Defense Research Sciences	01	271,933	253,116	253,116					U
3	0601103A	University Research Initiatives	01	67,225	69,166	69,166					U
4	0601104A	University and Industry Research Centers	01	99,148	94,280	94,280					U
	Basic Research			450,831	428,943	428,943					
5	0602105A	Materials Technology	02	67,806	31,533	31,533					U
6	0602120A	Sensors and Electronic Survivability	02	57,202	36,109	36,109					U
7	0602122A	TRACTOR HIP	02	6,879	6,995	6,995					U
8	0602211A	Aviation Technology	02	58,497	65,914	65,914					U
9	0602270A	Electronic Warfare Technology	02	18,502	25,466	25,466					U
10	0602303A	Missile Technology	02	51,801	44,313	44,313					U
11	0602307A	Advanced Weapons Technology	02	36,906	28,803	28,803					U
12	0602308A	Advanced Concepts and Simulation	02	26,886	27,688	27,688					U
13	0602601A	Combat Vehicle and Automotive Technology	02	95,763	67,959	67,959					U
14	0602618A	Ballistics Technology	02	118,221	85,436	85,436					U
15	0602622A	Chemical, Smoke and Equipment Defeating Technology	02	3,713	3,923	3,923					U
16	0602623A	Joint Service Small Arms Program	02	5,270	5,545	5,545					U
17	0602624A	Weapons and Munitions Technology	02	81,447	53,581	53,581					U

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1	0601101A	In-House Laboratory Independent Research	01	12,381	12,381		12,381	12,010		12,010	U
2	0601102A	Defense Research Sciences	01	253,116	253,116		253,116	263,590		263,590	U
3	0601103A	University Research Initiatives	01	69,166	69,166		69,166	67,027		67,027	U
4	0601104A	University and Industry Research Centers	01	94,280	94,280		94,280	87,395		87,395	U
	Basic	Research		428,943	428,943		428,943	430,022		430,022	
5	0602105A	Materials Technology	02	31,533	31,533		31,533	29,640		29,640	U
6	0602120A	Sensors and Electronic Survivability	02	36,109	36,109		36,109	35,730		35,730	U
7	0602122A	TRACTOR HIP	02	6,995	6,995		6,995	8,627		8,627	U
8	0602211A	Aviation Technology	02	65,914	65,914		65,914	66,086		66,086	U
9	0602270A	Electronic Warfare Technology	02	25,466	25,466		25,466	27,144		27,144	U
10	0602303A	Missile Technology	02	44,313	44,313		44,313	43,742		43,742	U
11	0602307A	Advanced Weapons Technology	02	28,803	28,803		28,803	22,785		22,785	U
12	0602308A	Advanced Concepts and Simulation	02	27,688	27,688		27,688	28,650		28,650	U
13	0602601A	Combat Vehicle and Automotive Technology	02	67,959	67,959		67,959	67,232		67,232	U
14	0602618A	Ballistics Technology	02	85,436	85,436		85,436	85,309		85,309	U
15	0602622A	Chemical, Smoke and Equipment Defeating Technology	02	3,923	3,923		3,923	4,004		4,004	U
16	0602623A	Joint Service Small Arms Program	02	5,545	5,545		5,545	5,615		5,615	U
17	0602624A	Weapons and Munitions Technology	02	53,581	53,581		53,581	41,455		41,455	U

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18	0602705A	Electronics and Electronic Devices	02	62,654	56,322	56,322					U
19	0602709A	Night Vision Technology	02	37,501	36,079	36,079					U
20	0602712A	Countermine Systems	02	35,586	26,497	26,497					U
21	0602716A	Human Factors Engineering Technology	02	23,220	23,671	23,671					U
22	0602720A	Environmental Quality Technology	02	20,270	22,151	22,151					U
23	0602782A	Command, Control, Communications Technology	02	34,749	37,803	37,803					U
24	0602783A	Computer and Software Technology	02	12,266	13,811	13,811					U
25	0602784A	Military Engineering Technology	02	80,130	67,416	67,416					U
26	0602785A	Manpower/Personnel/Training Technology	02	22,474	26,045	26,045					U
27	0602786A	Warfighter Technology	02	38,420	37,403	37,403					U
28	0602787A	Medical Technology	02	74,186	77,111	77,111					U
		Applied Research		1,070,349	907,574	907,574					
29	0603001A	Warfighter Advanced Technology	03	54,606	38,831	38,831					U
30	0603002A	Medical Advanced Technology	03	103,753	68,365	68,365					U
31	0603003A	Aviation Advanced Technology	03	99,542	94,280	94,280					U
32	0603004A	Weapons and Munitions Advanced Technology	03	95,504	68,714	68,714					U
33	0603005A	Combat Vehicle and Automotive Advanced Technology	03	136,624	122,132	122,132					U
34	0603006A	Space Application Advanced Technology	03	5,384	3,904	3,904					U

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18	0602705A	Electronics and Electronic Devices	02	56,322	56,322		56,322	58,352		58,352	U
19	0602709A	Night Vision Technology	02	36,079	36,079		36,079	34,723		34,723	U
20	0602712A	Countermine Systems	02	26,497	26,497		26,497	26,190		26,190	U
21	0602716A	Human Factors Engineering Technology	02	23,671	23,671		23,671	24,127		24,127	U
22	0602720A	Environmental Quality Technology	02	22,151	22,151		22,151	21,678		21,678	U
23	0602782A	Command, Control, Communications Technology	02	37,803	37,803		37,803	33,123		33,123	U
24	0602783A	Computer and Software Technology	02	13,811	13,811		13,811	14,041		14,041	U
25	0602784A	Military Engineering Technology	02	67,416	67,416		67,416	67,720		67,720	U
26	0602785A	Manpower/Personnel/Training Technology	02	26,045	26,045		26,045	20,216		20,216	U
27	0602786A	Warfighter Technology	02	37,403	37,403		37,403	39,559		39,559	U
28	0602787A	Medical Technology	02	77,111	77,111		77,111	83,434		83,434	U
		Applied Research		907,574	907,574		907,574	889,182		889,182	
29	0603001A	Warfighter Advanced Technology	03	38,831	38,831		38,831	44,863		44,863	U
30	0603002A	Medical Advanced Technology	03	68,365	68,365		68,365	67,780		67,780	U
31	0603003A	Aviation Advanced Technology	03	94,280	94,280		94,280	160,746		160,746	U
32	0603004A	Weapons and Munitions Advanced Technology	03	68,714	68,714		68,714	84,079		84,079	U
33	0603005A	Combat Vehicle and Automotive Advanced Technology	03	122,132	122,132		122,132	125,537		125,537	U
34	0603006A	Space Application Advanced Technology	03	3,904	3,904		3,904	12,231		12,231	U

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35	0603007A	Manpower, Personnel and Training Advanced Technology	03	11,571	14,417	14,417					U
36	0603009A	TRACTOR HIKE	03	9,002	8,074	21,374					U
37	0603015A	Next Generation Training & Simulation Systems	03	16,735	18,969	18,969					U
38	0603020A	TRACTOR ROSE	03	11,912	11,910	11,910					U
39	0603125A	Combating Terrorism - Technology Development	03	32,430	27,686	27,686					U
40	0603130A	TRACTOR NAIL	03	2,381	2,340	2,340					U
41	0603131A	TRACTOR EGGS	03	2,431	2,470	2,470					U
42	0603270A	Electronic Warfare Technology	03	31,810	27,893	27,893					U
43	0603313A	Missile and Rocket Advanced Technology	03	102,490	52,190	52,190					U
44	0603322A	TRACTOR CAGE	03	10,999	11,107	11,107					U
45	0603461A	High Performance Computing Modernization Program	03	215,138	177,190	177,190					U
46	0603606A	Landmine Warfare and Barrier Advanced Technology	03	13,425	17,451	17,451					U
47	0603607A	Joint Service Small Arms Program	03	4,903	5,839	5,839					U
48	0603710A	Night Vision Advanced Technology	03	39,329	44,468	44,468					U
49	0603728A	Environmental Quality Technology Demonstrations	03	14,533	11,137	11,137					U
50	0603734A	Military Engineering Advanced Technology	03	26,247	20,684	20,684					U

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35	0603007A	Manpower, Personnel and Training Advanced Technology	03	14,417	14,417		14,417	6,466		6,466	U
36	0603009A	TRACTOR HIKE	03	8,074	21,374		21,374	28,552		28,552	U
37	0603015A	Next Generation Training & Simulation Systems	03	18,969	18,969		18,969	16,434		16,434	U
38	0603020A	TRACTOR ROSE	03	11,910	11,910		11,910				U
39	0603125A	Combating Terrorism - Technology Development	03	27,686	27,686		27,686	26,903		26,903	U
40	0603130A	TRACTOR NAIL	03	2,340	2,340		2,340	4,880		4,880	U
41	0603131A	TRACTOR EGGS	03	2,470	2,470		2,470	4,326		4,326	U
42	0603270A	Electronic Warfare Technology	03	27,893	27,893		27,893	31,296		31,296	U
43	0603313A	Missile and Rocket Advanced Technology	03	52,190	52,190		52,190	62,850		62,850	U
44	0603322A	TRACTOR CAGE	03	11,107	11,107		11,107	12,323		12,323	U
45	0603461A	High Performance Computing Modernization Program	03	177,190	177,190		177,190	182,331		182,331	U
46	0603606A	Landmine Warfare and Barrier Advanced Technology	03	17,451	17,451		17,451	17,948		17,948	U
47	0603607A	Joint Service Small Arms Program	03	5,839	5,839		5,839	5,796		5,796	U
48	0603710A	Night Vision Advanced Technology	03	44,468	44,468		44,468	47,135		47,135	U
49	0603728A	Environmental Quality Technology Demonstrations	03	11,137	11,137		11,137	10,421		10,421	U
50	0603734A	Military Engineering Advanced Technology	03	20,684	20,684		20,684	32,448		32,448	U

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51	0603772A	Advanced Tactical Computer Science and Sensor Technology	03	36,658	44,239	44,239					U
52	0603794A	C3 Advanced Technology	03	36,339	35,775	35,775					U
		Advanced Technology Development		1,113,746	930,065	943,365					
53	0603305A	Army Missle Defense Systems Integration	04	29,270	9,433	9,433					U
54	0603308A	Army Space Systems Integration	04	29,561	23,056	23,056	9,375	9,375		9,375	U
55	0603327A	Air and Missile Defense Systems Engineering	04			14,200					U
56	0603619A	Landmine Warfare and Barrier - Adv Dev	04	40,943	72,117	72,117					U
57	0603627A	Smoke, Obscurant and Target Defeating Sys-Adv Dev	04	12,894	28,244	28,244		16,020		16,020	U
58	0603639A	Tank and Medium Caliber Ammunition	04	42,272	40,096	42,096					U
59	0603645A	Armored System Modernization - Adv Dev	04								U
60	0603747A	Soldier Support and Survivability	04	5,035	10,506	10,506					U
61	0603766A	Tactical Electronic Surveillance System - Adv Dev	04	17,562	15,730	15,730					U
62	0603774A	Night Vision Systems Advanced Development	04	7,003	10,321	10,321					U
63	0603779A	Environmental Quality Technology - Dem/Val	04	8,464	7,785	7,785					U
64	0603790A	NATO Research and Development	04	5,835	2,300	2,300					U
65	0603801A	Aviation - Adv Dev	04		10,014	10,014					U

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51	0603772A	Advanced Tactical Computer Science and Sensor Technology	03	44,239	44,239		44,239	52,206		52,206	U
52	0603794A	C3 Advanced Technology	03	35,775	35,775		35,775	33,426		33,426	U
		Advanced Technology Development		930,065	943,365		943,365	1,070,977		1,070,977	
53	0603305A	Army Missle Defense Systems Integration	04	9,433	9,433		9,433	9,634		9,634	U
54	0603308A	Army Space Systems Integration	04	32,431	32,431		32,431				U
55	0603327A	Air and Missile Defense Systems Engineering	04		14,200		14,200	33,949	15,000	48,949	U
56	0603619A	Landmine Warfare and Barrier - Adv Dev	04	72,117	72,117		72,117	72,909		72,909	U
57	0603627A	Smoke, Obscurant and Target Defeating Sys-Adv Dev	04	28,244	44,264		44,264	7,135		7,135	U
58	0603639A	Tank and Medium Caliber Ammunition	04	40,096	42,096		42,096	41,452		41,452	U
59	0603645A	Armored System Modernization - Adv Dev	04					32,739		32,739	U
60	0603747A	Soldier Support and Survivability	04	10,506	10,506		10,506	10,157	3,000	13,157	U
61	0603766A	Tactical Electronic Surveillance System - Adv Dev	04	15,730	15,730		15,730	27,733		27,733	U
62	0603774A	Night Vision Systems Advanced Development	04	10,321	10,321		10,321	12,347		12,347	U
63	0603779A	Environmental Quality Technology - Dem/Val	04	7,785	7,785		7,785	10,456		10,456	U
64	0603790A	NATO Research and Development	04	2,300	2,300		2,300	2,588		2,588	U
65	0603801A	Aviation - Adv Dev	04	10,014	10,014		10,014	14,055		14,055	U

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66	0603804A	Logistics and Engineer Equipment - Adv Dev	04	20,271	20,834	20,834					U
67	0603807A	Medical Systems - Adv Dev	04	39,711	33,503	33,503					U
68	0603827A	Soldier Systems - Advanced Development	04	22,251	31,120	31,120					U
69	0604017A	Robotics Development	04								U
70	0604100A	Analysis Of Alternatives	04	7,533	6,608	6,608					U
71	0604114A	Lower Tier Air Missile Defense (LTAMD) Sensor	04		35,132	35,132					U
72	0604115A	Technology Maturation Initiatives	04	34,493	70,047	70,047					U
73	0604117A	Maneuver - Short Range Air Defense (M-SHORAD)	04								U
74	0604118A	TRACTOR BEAM	04								U
75	0604120A	Assured Positioning, Navigation and Timing (PNT)	04	26,967	83,279	83,279					U
76	0604121A	Synthetic Training Environment Refinement & Prototyping	04								U
77	0604319A	Indirect Fire Protection Capability Increment 2-Intercept (IFPC2)	04	149,222							U
78	0305251A	Cyberspace Operations Forces and Force Support	04		40,510	40,510					U
79	1206308A	Army Space Systems Integration	04								U
		Advanced Component Development & Prototypes		499,287	550,635	566,835	9,375	25,395		25,395	
80	0604201A	Aircraft Avionics	05	18,194	83,248	83,248					U

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66	0603804A	Logistics and Engineer Equipment - Adv Dev	04	20,834	20,834		20,834	35,333		35,333	U
67	0603807A	Medical Systems - Adv Dev	04	33,503	33,503		33,503	33,491		33,491	U
68	0603827A	Soldier Systems - Advanced Development	04	31,120	31,120		31,120	20,239		20,239	U
69	0604017A	Robotics Development	04					39,608		39,608	U
70	0604100A	Analysis Of Alternatives	04	6,608	6,608		6,608	9,921		9,921	U
71	0604114A	Lower Tier Air Missile Defense (LTAMD) Sensor	04	35,132	35,132		35,132	76,728		76,728	U
72	0604115A	Technology Maturation Initiatives	04	70,047	70,047		70,047	115,221		115,221	U
73	0604117A	Maneuver - Short Range Air Defense (M-SHORAD)	04					20,000		20,000	U
74	0604118A	TRACTOR BEAM	04					10,400		10,400	U
75	0604120A	Assured Positioning, Navigation and Timing (PNT)	04	83,279	83,279		83,279	164,967		164,967	U
76	0604121A	Synthetic Training Environment Refinement & Prototyping	04					1,600		1,600	U
77	0604319A	Indirect Fire Protection Capability Increment 2-Intercept (IFPC2)	04					11,303		11,303	U
78	0305251A	Cyberspace Operations Forces and Force Support	04	40,510	40,510		40,510	56,492		56,492	U
79	1206308A	Army Space Systems Integration	04					20,432		20,432	U
		Advanced Component Development & Prototypes		560,010	592,230		592,230	890,889	18,000	908,889	
80	0604201A	Aircraft Avionics	05	83,248	83,248		83,248	30,153		30,153	U

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81	0604270A	Electronic Warfare Development	05	20,586	34,642	37,242					U
82	0604280A	Joint Tactical Radio	05	4,415							U
83	0604290A	Mid-tier Networking Vehicular Radio (MNVR)	05	8,416	12,172	12,172					U
84	0604321A	All Source Analysis System	05	4,309	3,958	3,958					U
85	0604328A	TRACTOR CAGE	05	15,138	12,525	12,525					U
86	0604601A	Infantry Support Weapons	05	86,966	66,943	66,943					U
87	0604604A	Medium Tactical Vehicles	05								U
88	0604611A	JAVELIN	05	3,789	20,011	20,011					U
89	0604622A	Family of Heavy Tactical Vehicles	05		11,429	11,429					U
90	0604633A	Air Traffic Control	05	9,714	3,421	3,421					U
91	0604641A	Tactical Unmanned Ground Vehicle (TUGV)	05	13,599	39,282	39,282					U
92	0604642A	Light Tactical Wheeled Vehicles	05		494	494					U
93	0604645A	Armored Systems Modernization (ASM) - Eng Dev	05		9,678	9,678					U
94	0604710A	Night Vision Systems - Eng Dev	05	65,482	84,519	84,519					U
95	0604713A	Combat Feeding, Clothing, and Equipment	05	1,694	2,054	2,054					U
96	0604715A	Non-System Training Devices - Eng Dev	05	26,768	30,774	35,774	33	33		33	U
97	0604741A	Air Defense Command, Control and Intelligence - Eng Dev	05	33,619	53,332	61,532		143,900	-78,700	65,200	U

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81	0604270A	Electronic Warfare Development	05	34,642	37,242		37,242	71,671		71,671	U
82	0604280A	Joint Tactical Radio	05								U
83	0604290A	Mid-tier Networking Vehicular Radio (MNVR)	05	12,172	12,172		12,172	10,589		10,589	U
84	0604321A	All Source Analysis System	05	3,958	3,958		3,958	4,774		4,774	U
85	0604328A	TRACTOR CAGE	05	12,525	12,525		12,525	17,252		17,252	U
86	0604601A	Infantry Support Weapons	05	66,943	66,943		66,943	87,643		87,643	U
87	0604604A	Medium Tactical Vehicles	05					6,039		6,039	U
88	0604611A	JAVELIN	05	20,011	20,011		20,011	21,095		21,095	U
89	0604622A	Family of Heavy Tactical Vehicles	05	11,429	11,429		11,429	10,507		10,507	U
90	0604633A	Air Traffic Control	05	3,421	3,421		3,421	3,536		3,536	U
91	0604641A	Tactical Unmanned Ground Vehicle (TUGV)	05	39,282	39,282		39,282				U
92	0604642A	Light Tactical Wheeled Vehicles	05	494	494		494	7,000		7,000	U
93	0604645A	Armored Systems Modernization (ASM) - Eng Dev	05	9,678	9,678		9,678	36,242		36,242	U
94	0604710A	Night Vision Systems - Eng Dev	05	84,519	84,519		84,519	108,504		108,504	U
95	0604713A	Combat Feeding, Clothing, and Equipment	05	2,054	2,054		2,054	3,702		3,702	U
96	0604715A	Non-System Training Devices - Eng Dev	05	30,807	35,807		35,807	43,575		43,575	U
97	0604741A	Air Defense Command, Control and Intelligence - Eng Dev	05	132,032	205,432	-78,700	126,732	28,726		28,726	U

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98	0604742A	Constructive Simulation Systems Development	05	22,609	17,887	17,887					U
99	0604746A	Automatic Test Equipment Development	05	8,636	8,813	8,813					U
100	0604760A	Distributive Interactive Simulations (DIS) - Eng Dev	05	8,843	10,487	10,487					U
101	0604768A	Brilliant Anti-Armor Submunition (BAT)	05								U
102	0604780A	Combined Arms Tactical Trainer (CATT) Core	05	20,808	15,068	15,068					U
103	0604798A	Brigade Analysis, Integration and Evaluation	05	96,286	89,716	146,655					U
104	0604802A	Weapons and Munitions - Eng Dev	05	18,037	80,365	99,165					U
105	0604804A	Logistics and Engineer Equipment - Eng Dev	05	43,229	75,098	75,098					U
106	0604805A	Command, Control, Communications Systems - Eng Dev	05	2,780	4,245	4,245					U
107	0604807A	Medical Materiel/Medical Biological Defense Equipment - Eng Dev	05	39,295	41,124	41,124					U
108	0604808A	Landmine Warfare/Barrier - Eng Dev	05	63,028	39,630	39,630					U
109	0604818A	Army Tactical Command & Control Hardware & Software	05	125,107	205,590	205,590					U
110	0604820A	Radar Development	05	11,821	15,983	15,983					U
111	0604822A	General Fund Enterprise Business System (GFEBS)	05	20,533	6,805	6,805					U
112	0604823A	Firefinder	05	2,850	9,235	9,235					U

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98	0604742A	Constructive Simulation Systems Development	05	17,887	17,887		17,887	18,562		18,562	U
99	0604746A	Automatic Test Equipment Development	05	8,813	8,813		8,813	8,344		8,344	U
100	0604760A	Distributive Interactive Simulations (DIS) - Eng Dev	05	10,487	10,487		10,487	11,270		11,270	U
101	0604768A	Brilliant Anti-Armor Submunition (BAT)	05					10,000		10,000	U
102	0604780A	Combined Arms Tactical Trainer (CATT) Core	05	15,068	15,068		15,068	18,566		18,566	U
103	0604798A	Brigade Analysis, Integration and Evaluation	05	89,716	146,655		146,655	145,360		145,360	U
104	0604802A	Weapons and Munitions - Eng Dev	05	80,365	99,165		99,165	145,232		145,232	U
105	0604804A	Logistics and Engineer Equipment - Eng Dev	05	75,098	75,098		75,098	90,965		90,965	U
106	0604805A	Command, Control, Communications Systems - Eng Dev	05	4,245	4,245		4,245	9,910		9,910	U
107	0604807A	Medical Materiel/Medical Biological Defense Equipment - Eng Dev	05	41,124	41,124		41,124	39,238		39,238	U
108	0604808A	Landmine Warfare/Barrier - Eng Dev	05	39,630	39,630		39,630	34,684		34,684	U
109	0604818A	Army Tactical Command & Control Hardware & Software	05	205,590	205,590		205,590	164,409		164,409	U
110	0604820A	Radar Development	05	15,983	15,983		15,983	32,968		32,968	U
111	0604822A	General Fund Enterprise Business System (GFEBS)	05	6,805	6,805		6,805	49,554		49,554	U
112	0604823A	Firefinder	05	9,235	9,235		9,235	45,605		45,605	U

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113	0604827A	Soldier Systems - Warrior Dem/Val	05	15,694	12,393	12,393					U
114	0604852A	Suite of Survivability Enhancement Systems - EMD	05								U
115	0604854A	Artillery Systems - EMD	05	2,251	1,756	4,506					U
116	0605013A	Information Technology Development	05	48,028	74,236	74,236					U
117	0605018A	Integrated Personnel and Pay System-Army (IPPS-A)	05	116,215	155,584	155,584					U
118	0605028A	Armored Multi-Purpose Vehicle (AMPV)	05	213,034	184,221	184,221					U
119	0605029A	Integrated Ground Security Surveillance Response Capability (IGSSR-C)	05		4,980	4,980					U
120	0605030A	Joint Tactical Network Center (JTNC)	05	12,834	15,041	15,041					U
121	0605031A	Joint Tactical Network (JTN)	05	20,790	16,014	16,014					U
122	0605032A	TRACTOR TIRE	05	10,677	27,254	27,254		10,000		10,000	U
123	0605033A	Ground-Based Operational Surveillance System - Expeditionary (GBOSS-E)	05		5,032	5,032					U
124	0605034A	Tactical Security System (TSS)	05		2,904	2,904					U
125	0605035A	Common Infrared Countermeasures (CIRCM)	05	98,496	96,977	96,977	10,900	10,900		10,900	U
126	0605036A	Combating Weapons of Mass Destruction (CWMD)	05		2,089	2,089					U
127	0605037A	Evidence Collection and Detainee Processing	05								U

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113	0604827A	Soldier Systems - Warrior Dem/Val	05	12,393	12,393		12,393	16,127		16,127	U
114	0604852A	Suite of Survivability Enhancement Systems - EMD	05					98,600		98,600	U
115	0604854A	Artillery Systems - EMD	05	1,756	4,506		4,506	1,972		1,972	U
116	0605013A	Information Technology Development	05	74,236	74,236		74,236	81,776		81,776	U
117	0605018A	Integrated Personnel and Pay System-Army (IPPS-A)	05	155,584	155,584		155,584	172,361		172,361	U
118	0605028A	Armored Multi-Purpose Vehicle (AMPV)	05	184,221	184,221		184,221	199,778		199,778	U
119	0605029A	Integrated Ground Security Surveillance Response Capability (IGSSR-C)	05	4,980	4,980		4,980	4,418		4,418	U
120	0605030A	Joint Tactical Network Center (JTNC)	05	15,041	15,041		15,041	15,877		15,877	U
121	0605031A	Joint Tactical Network (JTN)	05	16,014	16,014		16,014	44,150		44,150	U
122	0605032A	TRACTOR TIRE	05	27,254	37,254		37,254	34,670	5,000	39,670	U
123	0605033A	Ground-Based Operational Surveillance System - Expeditionary (GBOSS-E)	05	5,032	5,032		5,032	5,207		5,207	U
124	0605034A	Tactical Security System (TSS)	05	2,904	2,904		2,904	4,727		4,727	U
125	0605035A	Common Infrared Countermeasures (CIRCM)	05	107,877	107,877		107,877	105,778	21,540	127,318	U
126	0605036A	Combating Weapons of Mass Destruction (CWMD)	05	2,089	2,089		2,089	6,927		6,927	U
127	0605037A	Evidence Collection and Detainee Processing	05					214		214	U

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128	0605038A	Nuclear Biological Chemical Reconnaissance Vehicle (NBCRV) Sensor Suite	05								U
129	0605041A	Defensive CYBER Tool Development	05		33,836	33,836		50,500		50,500	U
130	0605042A	Tactical Network Radio Systems (Low-Tier)	05		18,824	18,824					U
131	0605047A	Contract Writing System	05		20,663	20,663					U
132	0605049A	Missile Warning System Modernization (MWSM)	05								U
133	0605051A	Aircraft Survivability Development	05	77,395	41,133	51,133	73,110	73,110		73,110	U
134	0605052A	Indirect Fire Protection Capability Inc 2 - Block 1	05		83,995	83,995					U
135	0605053A	Ground Robotics	05								U
136	0605350A	WIN-T Increment 3 - Full Networking	05	32,187							U
137	0605380A	AMF Joint Tactical Radio System (JTRS)	05	10,143	5,028	5,028					U
138	0605450A	Joint Air-to-Ground Missile (JAGM)	05	79,897	42,972	42,972					U
139	0605456A	PAC-3/MSE Missile	05	2,201							U
140	0605457A	Army Integrated Air and Missile Defense (AIAMD)	05	222,074	252,811	272,811					U
141	0605625A	Manned Ground Vehicle	05	37,692							U
142	0605626A	Aerial Common Sensor	05	2							U
143	0605766A	National Capabilities Integration (MIP)	05	10,599	4,955	4,955					U

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128	0605038A	Nuclear Biological Chemical Reconnaissance Vehicle (NBCRV) Sensor Suite	05					16,125		16,125	U
129	0605041A	Defensive CYBER Tool Development	05	33,836	84,336		84,336	55,165		55,165	U
130	0605042A	Tactical Network Radio Systems (Low-Tier)	05	18,824	18,824		18,824	20,076		20,076	U
131	0605047A	Contract Writing System	05	20,663	20,663		20,663	20,322		20,322	U
132	0605049A	Missile Warning System Modernization (MWSM)	05					55,810		55,810	U
133	0605051A	Aircraft Survivability Development	05	114,243	124,243		124,243	30,879	30,100	60,979	U
134	0605052A	Indirect Fire Protection Capability Inc 2 - Block 1	05	83,995	83,995		83,995	175,069		175,069	U
135	0605053A	Ground Robotics	05					70,760		70,760	U
136	0605350A	WIN-T Increment 3 - Full Networking	05								U
137	0605380A	AMF Joint Tactical Radio System (JTRS)	05	5,028	5,028		5,028	8,965		8,965	U
138	0605450A	Joint Air-to-Ground Missile (JAGM)	05	42,972	42,972		42,972	34,626		34,626	U
139	0605456A	PAC-3/MSE Missile	05								U
140	0605457A	Army Integrated Air and Missile Defense (AIAMD)	05	252,811	272,811		272,811	336,420		336,420	U
141	0605625A	Manned Ground Vehicle	05								U
142	0605626A	Aerial Common Sensor	05								U
143	0605766A	National Capabilities Integration (MIP)	05	4,955	4,955		4,955	6,882		6,882	U

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144	0605812A	Joint Light Tactical Vehicle (JLTV) Engineering and Manufacturing Development Ph	05	31,197	11,530	11,530					U
145	0605830A	Aviation Ground Support Equipment	05	13,528	2,142	2,142					U
146	0210609A	Paladin Integrated Management (PIM)	05	136,353	41,498	41,498					U
147	0303032A	TROJAN - RH12	05	5,022	4,273	4,273					U
148	0303267A	Auctioned Spectrum Relocation Fund	05	71,823							U
149	0303367A	Spectrum Access Research and Development	05	125,283							U
150	0304270A	Electronic Warfare Development	05	12,686	14,425	18,425					U
151	1205117A	Tractor Bears	05								U
		System Development & Demonstration		2,202,652	2,265,094	2,393,383	84,043	288,443	-78,700	209,743	
152	0604256A	Threat Simulator Development	06	27,157	25,675	25,675					U
153	0604258A	Target Systems Development	06	16,163	19,122	19,122					U
154	0604759A	Major T&E Investment	06	65,059	84,777	84,777					U
155	0605103A	Rand Arroyo Center	06	20,014	20,658	20,658					U
156	0605301A	Army Kwajalein Atoll	06	200,393	236,648	236,648					U
157	0605326A	Concepts Experimentation Program	06	18,705	25,596	25,596					U
158	0605502A	Small Business Innovative Research	06	220,833							U
159	0605601A	Army Test Ranges and Facilities	06	273,275	293,748	307,882					U
160	0605602A	Army Technical Test Instrumentation and Targets	06	52,254	52,404	64,127					U

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144	0605812A	Joint Light Tactical Vehicle (JLTV) Engineering and Manufacturing Development Ph	05	11,530	11,530		11,530	23,467		23,467	U
145	0605830A	Aviation Ground Support Equipment	05	2,142	2,142		2,142	6,930		6,930	U
146	0210609A	Paladin Integrated Management (PIM)	05	41,498	41,498		41,498	6,112		6,112	U
147	0303032A	TROJAN - RH12	05	4,273	4,273		4,273	4,431	1,200	5,631	U
148	0303267A	Auctioned Spectrum Relocation Fund	05								U
149	0303367A	Spectrum Access Research and Development	05								U
150	0304270A	Electronic Warfare Development	05	14,425	18,425		18,425	14,616		14,616	U
151	1205117A	Tractor Bears	05					17,928		17,928	U
		System Development & Demonstration		2,427,837	2,681,826	-78,700	2,603,126	3,012,840	57,840	3,070,680	
152	0604256A	Threat Simulator Development	06	25,675	25,675		25,675	22,862		22,862	U
153	0604258A	Target Systems Development	06	19,122	19,122		19,122	13,902		13,902	U
154	0604759A	Major T&E Investment	06	84,777	84,777		84,777	102,901		102,901	U
155	0605103A	Rand Arroyo Center	06	20,658	20,658		20,658	20,140		20,140	U
156	0605301A	Army Kwajalein Atoll	06	236,648	236,648		236,648	246,663		246,663	U
157	0605326A	Concepts Experimentation Program	06	25,596	25,596		25,596	29,820		29,820	U
158	0605502A	Small Business Innovative Research	06								U
159	0605601A	Army Test Ranges and Facilities	06	293,748	307,882		307,882	307,588		307,588	U
160	0605602A	Army Technical Test Instrumentation and Targets	06	52,404	64,127		64,127	49,242		49,242	U

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161	0605604A	Survivability/Lethality Analysis	06	33,069	38,571	38,571					U
162	0605606A	Aircraft Certification	06	4,571	4,665	4,665					U
163	0605702A	Meteorological Support to RDT&E Activities	06	8,104	6,925	6,925					U
164	0605706A	Materiel Systems Analysis	06	20,203	21,677	21,677					U
165	0605709A	Exploitation of Foreign Items	06	10,396	12,415	12,415					U
166	0605712A	Support of Operational Testing	06	49,128	49,684	49,684					U
167	0605716A	Army Evaluation Center	06	52,265	55,905	55,905					U
168	0605718A	Army Modeling & Sim X-Cmd Collaboration & Integ	06	901	7,959	7,959					U
169	0605801A	Programwide Activities	06	61,060	51,822	51,822					U
170	0605803A	Technical Information Activities	06	25,991	33,323	33,323					U
171	0605805A	Munitions Standardization, Effectiveness and Safety	06	48,335	40,545	40,545					U
172	0605857A	Environmental Quality Technology Mgmt Support	06	3,673	2,130	2,130					U
173	0605898A	Army Direct Report Headquarters - R&D - MHA	06	48,312	49,885	49,885					U
174	0606001A	Military Ground-Based CREW Technology	06								U
175	0606002A	Ronald Reagan Ballistic Missile Defense Test Site	06								U
176	0303260A	Defense Military Deception Initiative	06		2,000	2,000					U

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161	0605604A	Survivability/Lethality Analysis	06	38,571	38,571		38,571	41,843		41,843	U
162	0605606A	Aircraft Certification	06	4,665	4,665		4,665	4,804		4,804	U
163	0605702A	Meteorological Support to RDT&E Activities	06	6,925	6,925		6,925	7,238		7,238	U
164	0605706A	Materiel Systems Analysis	06	21,677	21,677		21,677	21,890		21,890	U
165	0605709A	Exploitation of Foreign Items	06	12,415	12,415		12,415	12,684		12,684	U
166	0605712A	Support of Operational Testing	06	49,684	49,684		49,684	51,040		51,040	U
167	0605716A	Army Evaluation Center	06	55,905	55,905		55,905	56,246		56,246	U
168	0605718A	Army Modeling & Sim X-Cmd Collaboration & Integ	06	7,959	7,959		7,959	1,829		1,829	U
169	0605801A	Programwide Activities	06	51,822	51,822		51,822	55,060		55,060	U
170	0605803A	Technical Information Activities	06	33,323	33,323		33,323	33,934		33,934	U
171	0605805A	Munitions Standardization, Effectiveness and Safety	06	40,545	40,545		40,545	43,444		43,444	U
172	0605857A	Environmental Quality Technology Mgmt Support	06	2,130	2,130		2,130	5,087		5,087	U
173	0605898A	Army Direct Report Headquarters - R&D - MHA	06	49,885	49,885		49,885	54,679		54,679	U
174	0606001A	Military Ground-Based CREW Technology	06					7,916		7,916	U
175	0606002A	Ronald Reagan Ballistic Missile Defense Test Site	06					61,254		61,254	U
176	0303260A	Defense Military Deception Initiative	06	2,000	2,000		2,000	1,779		1,779	U

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177	0909999A	Financing for Cancelled Account Adjustments	06	65							U
	RDT&E	Management Support		1,259,926	1,136,134	1,161,991					
178	0603778A	MLRS Product Improvement Program	07	21,202	9,663	34,763					U
179	0603813A	TRACTOR PULL	07	9,461	3,960	3,960					U
180	0605024A	Anti-Tamper Technology Support	07		3,638	3,638					U
181	0607131A	Weapons and Munitions Product Improvement Programs	07	5,678	14,517	14,517		5,100		5,100	U
182	0607133A	TRACTOR SMOKE	07	7,569	4,479	4,479					U
183	0607134A	Long Range Precision Fires (LRPF)	07		39,275	67,006					U
184	0607135A	Apache Product Improvement Program	07	62,964	66,441	66,441					U
185	0607136A	Blackhawk Product Improvement Program	07	64,011	46,765	46,765					U
186	0607137A	Chinook Product Improvement Program	07	31,122	91,848	91,848					U
187	0607138A	Fixed Wing Product Improvement Program	07	1,105	796	796					U
188	0607139A	Improved Turbine Engine Program	07	49,137	126,105	126,105					U
189	0607140A	Emerging Technologies from NIE	07	2,383	2,369	2,369					U
190	0607141A	Logistics Automation	07	1,318	4,563	4,563					U
191	0607142A	Aviation Rocket System Product Improvement and Development	07			8,000					U
192	0607143A	Unmanned Aircraft System Universal Products	07								U

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177	0909999A	Financing for Cancelled Account Adjustments	06								U
	RDT&E	Management Support		1,136,134	1,161,991		1,161,991	1,253,845		1,253,845	
178	0603778A	MLRS Product Improvement Program	07	9,663	34,763		34,763	8,929		8,929	U
179	0603813A	TRACTOR PULL	07	3,960	3,960		3,960	4,014		4,014	U
180	0605024A	Anti-Tamper Technology Support	07	3,638	3,638		3,638	4,094		4,094	U
181	0607131A	Weapons and Munitions Product Improvement Programs	07	14,517	19,617		19,617	15,738		15,738	U
182	0607133A	TRACTOR SMOKE	07	4,479	4,479		4,479	4,513		4,513	U
183	0607134A	Long Range Precision Fires (LRPF)	07	39,275	67,006		67,006	102,014		102,014	U
184	0607135A	Apache Product Improvement Program	07	66,441	66,441		66,441	59,977		59,977	U
185	0607136A	Blackhawk Product Improvement Program	07	46,765	46,765		46,765	34,416		34,416	U
186	0607137A	Chinook Product Improvement Program	07	91,848	91,848		91,848	194,567		194,567	U
187	0607138A	Fixed Wing Product Improvement Program	07	796	796		796	9,981		9,981	U
188	0607139A	Improved Turbine Engine Program	07	126,105	126,105		126,105	204,304		204,304	U
189	0607140A	Emerging Technologies from NIE	07	2,369	2,369		2,369	1,023		1,023	U
190	0607141A	Logistics Automation	07	4,563	4,563		4,563	1,504		1,504	U
191	0607142A	Aviation Rocket System Product Improvement and Development	07		8,000		8,000	10,064		10,064	U
192	0607143A	Unmanned Aircraft System Universal Products	07					38,463		38,463	U

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193	0607665A	Family of Biometrics	07	7,179	12,098	12,098					U
194	0607865A	Patriot Product Improvement	07	87,537	49,482	49,482					U
195	0202429A	Aerostat Joint Project - COCOM Exercise	07	10,171	45,482	45,482					U
196	0203728A	Joint Automated Deep Operation Coordination System (JADOCS)	07	30,669	30,455	30,455					U
197	0203735A	Combat Vehicle Improvement Programs	07	382,176	316,857	327,357					U
198	0203740A	Maneuver Control System	07	14,864	4,031	4,031					U
199	0203743A	155mm Self-Propelled Howitzer Improvements	07								U
200	0203744A	Aircraft Modifications/Product Improvement Programs	07		35,793	35,793					U
201	0203752A	Aircraft Engine Component Improvement Program	07	349	259	259					U
202	0203758A	Digitization	07	4,188	6,483	6,483					U
203	0203801A	Missile/Air Defense Product Improvement Program	07	3,029	5,122	53,722					U
204	0203802A	Other Missile Product Improvement Programs	07	49,191	7,491	7,491		1,080		1,080	U
205	0203808A	TRACTOR CARD	07	34,686	20,333	20,333					U
206	0205402A	Integrated Base Defense - Operational System Dev	07	10,324				3,450		3,450	U
207	0205410A	Materials Handling Equipment	07	386	124	124					U
208	0205412A	Environmental Quality Technology - Operational System Dev	07								U

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Line No	Program Element Number	Item	Act	FY 2017 Total PB Requests** with CR Adj Base+OCO+SAA	FY 2017 Total PB Requests* with CR Adj Base + OCO	FY 2017 Less Enacted Div B P.L.114-254** OCO	FY 2017 Remaining Req with CR Adj Base + OCO	FY 2018 Base	FY 2018 OCO	FY 2018 Total	Sec
193	0607665A	Family of Biometrics	07	12,098	12,098		12,098	6,159		6,159	U
194	0607865A	Patriot Product Improvement	07	49,482	49,482		49,482	90,217		90,217	U
195	0202429A	Aerostat Joint Project - COCOM Exercise	07	45,482	45,482		45,482	6,749		6,749	U
196	0203728A	Joint Automated Deep Operation Coordination System (JADOCS)	07	30,455	30,455		30,455	33,520		33,520	U
197	0203735A	Combat Vehicle Improvement Programs	07	316,857	327,357		327,357	343,175		343,175	U
198	0203740A	Maneuver Control System	07	4,031	4,031		4,031	6,639		6,639	U
199	0203743A	155mm Self-Propelled Howitzer Improvements	07					40,784		40,784	U
200	0203744A	Aircraft Modifications/Product Improvement Programs	07	35,793	35,793		35,793	39,358		39,358	U
201	0203752A	Aircraft Engine Component Improvement Program	07	259	259		259	145		145	U
202	0203758A	Digitization	07	6,483	6,483		6,483	4,803		4,803	U
203	0203801A	Missile/Air Defense Product Improvement Program	07	5,122	53,722		53,722	2,723	15,000	17,723	U
204	0203802A	Other Missile Product Improvement Programs	07	7,491	8,571		8,571	5,000		5,000	U
205	0203808A	TRACTOR CARD	07	20,333	20,333		20,333	37,883		37,883	U
206	0205402A	Integrated Base Defense - Operational System Dev	07		3,450		3,450				U
207	0205410A	Materials Handling Equipment	07	124	124		124	1,582		1,582	U
208	0205412A	Environmental Quality Technology - Operational System Dev	07					195		195	U

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209	0205456A	Lower Tier Air and Missile Defense (AMD) System	07	61,653	69,417	73,417					U
210	0205778A	Guided Multiple-Launch Rocket System (GMLRS)	07	36,032	22,044	38,044					U
211	0208053A	Joint Tactical Ground System	07	28,015	12,649	12,649					U
213	0303028A	Security and Intelligence Activities	07	13,156	11,619	11,619					U
214	0303140A	Information Systems Security Program	07	31,032	38,280	38,280					U
215	0303141A	Global Combat Support System	07	25,304	27,223	28,667					U
216	0303142A	SATCOM Ground Environment (SPACE)	07	9,045	18,815	18,815					U
217	0303150A	WWMCCS/Global Command and Control System	07	6,810	4,718	4,718					U
219	0305127A	Foreign Counterintelligence Activities	07			4,100					U
220	0305172A	Combined Advanced Applications	07								U
221	0305179A	Integrated Broadcast Service (IBS)	07	750							U
222	0305204A	Tactical Unmanned Aerial Vehicles	07	15,370	8,218	8,218					U
223	0305206A	Airborne Reconnaissance Systems	07	20,725	11,799	11,799					U
224	0305208A	Distributed Common Ground/Surface Systems	07	25,592	32,284	32,284					U
225	0305219A	MQ-1C Gray Eagle UAS	07	22,285	13,470	30,970					U
226	0305232A	RQ-11 UAV	07		1,613	1,613					U
227	0305233A	RQ-7 UAV	07	11,797	4,597	7,597					U
228	0307665A	Biometrics Enabled Intelligence	07				7,104	8,854		8,854	U

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209	0205456A	Lower Tier Air and Missile Defense (AMD) System	07	69,417	73,417		73,417	78,926		78,926	U
210	0205778A	Guided Multiple-Launch Rocket System (GMLRS)	07	22,044	38,044		38,044	102,807		102,807	U
211	0208053A	Joint Tactical Ground System	07	12,649	12,649		12,649				U
213	0303028A	Security and Intelligence Activities	07	11,619	11,619		11,619	13,807		13,807	U
214	0303140A	Information Systems Security Program	07	38,280	38,280		38,280	132,438		132,438	U
215	0303141A	Global Combat Support System	07	27,223	28,667		28,667	64,370		64,370	U
216	0303142A	SATCOM Ground Environment (SPACE)	07	18,815	18,815		18,815				U
217	0303150A	WWMCCS/Global Command and Control System	07	4,718	4,718		4,718	10,475		10,475	U
219	0305127A	Foreign Counterintelligence Activities	07		4,100		4,100				U
220	0305172A	Combined Advanced Applications	07					1,100		1,100	U
221	0305179A	Integrated Broadcast Service (IBS)	07								U
222	0305204A	Tactical Unmanned Aerial Vehicles	07	8,218	8,218		8,218	9,433	7,492	16,925	U
223	0305206A	Airborne Reconnaissance Systems	07	11,799	11,799		11,799	5,080	15,000	20,080	U
224	0305208A	Distributed Common Ground/Surface Systems	07	32,284	32,284		32,284	24,700		24,700	U
225	0305219A	MQ-1C Gray Eagle UAS	07	13,470	30,970		30,970	9,574		9,574	U
226	0305232A	RQ-11 UAV	07	1,613	1,613		1,613	2,191		2,191	U
227	0305233A	RQ-7 UAV	07	4,597	7,597		7,597	12,773		12,773	U
228	0307665A	Biometrics Enabled Intelligence	07	7,104	8,854		8,854	2,537	6,036	8,573	U

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229	0310349A	Win-T Increment 2 - Initial Networking	07	3,649	4,867	4,867					U
230	0708045A	End Item Industrial Preparedness Activities	07	58,503	62,287	62,287					U
231	1203142A	SATCOM Ground Environment (SPACE)	07								U
232	1208053A	Joint Tactical Ground System	07								U
9999	9999999999	Classified Programs		4,536	4,625	4,625					U
		Operational Systems Development		1,264,953	1,296,954	1,462,929	7,104	18,484		18,484	
233	0901560A	Continuing Resolution Programs	20		32,395	32,395	-99,022	-99,022		-99,022	U
		Undistributed			32,395	32,395	-99,022	-99,022		-99,022	
Total Research, Development, Test & Eval, Army				7,861,744	7,547,794	7,897,415	1,500	233,300	-78,700	154,600	

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229	0310349A	Win-T Increment 2 - Initial Networking	07	4,867	4,867		4,867	4,723		4,723	U
230	0708045A	End Item Industrial Preparedness Activities	07	62,287	62,287		62,287	60,877		60,877	U
231	1203142A	SATCOM Ground Environment (SPACE)	07					11,959		11,959	U
232	1208053A	Joint Tactical Ground System	07					10,228		10,228	U
9999	9999999999	Classified Programs		4,625	4,625		4,625	7,154		7,154	U
		Operational Systems Development		1,304,058	1,481,413		1,481,413	1,877,685	43,528	1,921,213	
233	0901560A	Continuing Resolution Programs	20	-66,627	-66,627		-66,627				U
		Undistributed		-66,627	-66,627		-66,627				
Total Research, Development, Test & Eval, Army				7,627,994	8,130,715	-78,700	8,052,015	9,425,440	119,368	9,544,808	

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Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602105A *I Materials Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	67.806	31.533	29.640	-	29.640	29.120	29.941	30.862	31.186	-	-
H7B: *Advanced Materials Initiatives (CA)*	-	40.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-
H7G: *Nanomaterials Applied Research*	-	3.551	3.454	3.107	-	3.107	0.000	0.000	0.000	0.000	-	-
H84: *Materials*	-	24.255	28.079	26.533	-	26.533	29.120	29.941	30.862	31.186	-	-

A. Mission Description and Budget Item Justification

This Program Element (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 project 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/Squad portfolio.

Work in this PE builds on the materials research transitioned from PE 0601102A and 0601104A. 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 Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Work in this PE is performed by the Army Research Laboratory (ARL), Adelphi, MD and Aberdeen Proving Ground, MD and the Massachusetts Institute of Technology, and the Institute for Soldier Nanotechnologies (ISN) industrial partners through Fiscal Year (FY) 2017.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army	Date: May 2017
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602105A *I Materials Technology*

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	68.314	31.533	31.849	-	31.849
Current President's Budget	67.806	31.533	29.640	-	29.640
Total Adjustments	-0.508	0.000	-2.209	-	-2.209
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.508	-			
• Adjustments to Budget Years	0.000	0.000	-2.315	-	-2.315
• Civ Pay Adjustments	0.000	0.000	0.106	-	0.106

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2016	FY 2017
Project: H7B: *Advanced Materials Initiatives (CA)*		
Congressional Add: *Program Increase*	35.000	-
Congressional Add: *High Performance Polymers Research*	5.000	-
Congressional Add Subtotals for Project: H7B	40.000	-
Congressional Add Totals for all Projects	40.000	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040 / 2				R-1 Program Element (Number/Name) PE 0602105A / *Materials Technology*				Project (Number/Name) H7B / *Advanced Materials Initiatives (CA)*				
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
H7B: *Advanced Materials Initiatives (CA)*	-	40.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Advanced Materials Initiatives.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017
Congressional Add: Program Increase ***FY 2016 Accomplishments:*** This is a Congressional Interest Item.	35.000	-
Congressional Add: High Performance Polymers Research ***FY 2016 Accomplishments:*** This is a Congressional Interest Item	5.000	-
Congressional Adds Subtotals	40.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army									Date: May 2017			
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602105A / *Materials Technology*				Project (Number/Name) H7G / *Nanomaterials Applied Research*			
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
H7G: *Nanomaterials Applied Research*	-	3.551	3.454	3.107	-	3.107	0.000	0.000	0.000	0.000	-	-

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 Program Element (PE) 0601104A/project J12 (Institute for Soldier Nanotechnologies (ISN)) to advance innovative capabilities.

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

Work in this project builds on the materials research transitioned from PE 0601104A. 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 Assistant 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 Army Research Laboratory (ARL), Adelphi, MD and Aberdeen Proving Ground, MD, AND the Massachusetts Institute of Technology, and the ISN industrial partners.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Nanomaterials Applied Research	3.551	3.454	-
Description: Devise and validate improved physics-based, materials property models and concepts for multifunctional, lightweight, and responsive materials. Exploit breakthroughs in nanomaterials and multifunctional fiber processing technologies, such as scale-up of processes and fabrication into woven materials, to enable revolutionary future Soldier capabilities.			
FY 2016 Accomplishments: Developed nano-structured protective materials and associated processing capabilities to enable novel light-weight materials solutions with enhanced impact performance; and developed novel nano-materials that enable sensing and communication platforms through the use and optimization of size-dependent properties (e.g., quantum confinement) for detection and non-traditional communications.			
FY 2017 Plans:			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** H7G / *Nanomaterials Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will develop nano-enabled sensors that provide low cost detection of hazardous substances in a complex environment; and use novel quantum dot technology to develop materials for reconfigurable antenna applications.			
Title: Emerging Materials for Soldier Protection ***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. ***FY 2018 Plans:*** Will investigate and down-select promising materials technologies, and will fund research focused on achieving protection materials that enable a 20% reduction in weight relative to current systems.	-	-	3.107
Accomplishments/Planned Programs Subtotals	3.551	3.454	3.107

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army									Date: May 2017			
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602105A / *Materials Technology*				Project (Number/Name) H84 / *Materials*			
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
H84: *Materials*	-	24.255	28.079	26.533	-	26.533	29.120	29.941	30.862	31.186	-	-

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/Squad portfolios.

Work in this Project makes extensive use of high performance computing and experimental validation and builds on research transitioned from Program Element (PE) 0601102A (Defense Research Sciences), project H42 (Materials and Mechanics), and project H43 (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 Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

The work in this Project is conducted by the Army Research Laboratory (ARL) at Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Structural Armor Materials	5.207	5.338	3.996
Description: Conduct applied research to design and evaluate lightweight armor materialsand structures, investigate novel processing methodologies for cost effective manufacturing, use existing and emerging modeling and simulation tools to enable formulation of lightweight, frontal, and structural armor materials for current and future platform applications. Explore ground vehicle structural mechanics and dynamics technologies to improve damage tolerance, durability, fatigue-resistance, and dynamic response (shock, vibration, harshness, and damping).			
FY 2016 Accomplishments: Advanced the manufacturing science of magnesium alloys using specific combinations of processing techniques to impart unique structure and achieve large, high performance plates for armor applications; matured development of damage tolerance concepts for thick composites through refinement of novel experimental and simulation strategies that enable material property			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** H84 / *Materials*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
and performance optimization through control of processing parameters; investigated multiscale structure-property relationships and construct predictive characterization schemes with an aim to influence manufacturability of preferred properties. ***FY 2017 Plans:*** Will develop enhanced transparent protective materials by determining the role of material composition on ballistic performance of glass, and by establishing new processing science for producing transparent composites; and develop new strategies for modification of surfaces and interfaces in composite and nanocomposite systems to produce enhanced structural and ballistic materials. ***FY 2018 Plans:*** Will establish new processing science to produce transparent composites using material composition to control and optimize ballistic performance; will further mature new methods to modify surfaces and interfaces in composite and nanocomposite systems and produce small scale bulk composites with enhanced structural and ballistic materials.			
Title: Soldier-Borne Armor Materials ***Description:*** Utilizing understanding of defeat mechanisms from PE 0602618A/project H80, 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. ***FY 2016 Accomplishments:*** Developed lab-scale processing approaches for boron-based ceramics using dopants and glassy films to achieve dramatic toughness improvements; investigated energy absorption improvements in helmet padding materials; and developed a validated multi-physics model predicting microstructure and residual stress in ultra high molecular weight polyethylene (UHMWPE) composites as a function of process history to enable improvements in material properties through process optimization. ***FY 2017 Plans:*** Will develop methods to produce, characterize, and model layered 2-dimensional polymer and/or graphene composites to explore new protection concepts and will compare to traditional textile based protection; develop improved unidirectional laminates based on UHMWPE using new computational models; and validate multiscale models of protective fabrics that utilize single-fiber and sub-fiber level details to predict mechanical deformation and failure. ***FY 2018 Plans:*** Will explore synthetic scale-up for potential protection system design application; using computational models, will produce and characterize unidirectional laminates; using validation results of multiscale models, will adjust models to improve accuracy of deformation and failure predictions.	5.264	6.898	7.042
Title: Lethality Materials Technology	4.413	4.492	3.738

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** H84 / *Materials*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
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. ***FY 2016 Accomplishments:*** Advanced understanding of metal-based gun barrel materials by establishing wear properties and exploring active cooling technologies; determined properties and liner performance of nanostructured copper-based materials; and investigated alternative lower-cost compositions that will provide improved shape charge jet formation and performance of the liner. ***FY 2017 Plans:*** Will develop new Iron (Fe) based alloys using dispersion of oxides to create ultra-high strength, high toughness, and thermally stable materials for a range of lethality applications; utilize synthesis, characterization, and modeling to develop high energy density polymeric materials for use as energetic binders. ***FY 2018 Plans:*** Will validate iron based alloy and characterize integrity through a lethality application demonstration; will produce prototype high energy density polymeric materials and demonstrate their capability as energetic binders.			
Title: Multifunctional Armor Materials ***Description:*** This effort researches novel multifunctional armor materials and associated processing science aimed at enabling critical Army applications in survivability and sustainment. Research efforts include multifunctional protective films and coatings, joining of dissimilar materials, and additive manufacturing of multifunctional materials. Soldier personnel protection materials transition to PE 0602786A/project H98. Vehicle armor materials transition to PE 0602618A/project H80 and PE 0602601A/project C05 ***FY 2016 Accomplishments:*** Matured the additive manufacturing and processing of multi-component materials and developed a new simulation tool that links process science to the desired materials structure and properties; investigated the use of electromagnetic (EM) fields to control and optimize microstructure in metals and ceramics used in armor applications; assessed the formation of ceramic materials through the use of low temperature solidification processing using locally sourced materials; and investigated and characterized peptides (that act as glue in natural/biological materials in warm moist environments) with a goal of demonstrating triple the lifetime and strength in high humidity conditions. ***FY 2017 Plans:*** Will enhance computational capabilities to link additive manufacturing process science to the desired materials structure and properties while further expanding additive manufacturing capabilities; expand investigations in electromagnetic (EM) fields	7.436	9.356	9.697

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** H84 / *Materials*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
applications during processing of metals and ceramics to enable new abilities to control and optimize microstructures and develop new low temperature, low pressure processing methods; develop process modeling tools and related experimental capabilities to capture effects of EM fields during ceramic sintering and the resulting structure-property relationships. ***FY 2018 Plans:*** Will use newly enhanced computational capabilities that link additive manufacturing processes to desired structure and properties to produce small scale material; will identify specific electromagnetic processes to control specific microstructures to produce materials with optimized microstructures and desired properties using low temperature, low pressure electromagnetic processes; will use modeling tools to further design and mature ceramics exhibiting desired, predicted structures and properties.			
Title: Nanomaterials ***Description:*** Mature and scale-up nanomaterials processes, fabrication, characterization and performance measures to enable revolutionary concepts for future force lethality and survivability beyond those addressed for individual Soldier protection in PE 062105A (Materials Technology) / Project H7G (Nanomaterials Applied Research). ***FY 2016 Accomplishments:*** Developed nanocellulose-based fibers with surface modifications for improved toughness and demonstrated improved impact strength in nanocellulose composites; investigated scaled-up fabrication of thermally stable iron-based nanomaterials with enhanced strength and ductility; and determined performance capabilities of nanostructure copper-based shaped charge liners. ***FY 2017 Plans:*** Will synthesize novel small molecules and utilize nanostructured additives and other nanomaterials to develop new hybrid and multifunctional polymer coatings, composites, and films with enhanced dielectric and electromagnetic properties to enable new active / adaptive armor and weapons concepts. ***FY 2018 Plans:*** Will produce bulk material for active/adaptive armor and/or weapon material from newly developed hybrid, multifunctional polymer coatings, composites, and films with enhanced dielectric and electromagnetic properties.	1.935	1.995	2.060
Accomplishments/Planned Programs Subtotals	24.255	28.079	26.533

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** H84 / *Materials*

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602120A / *Sensors and Electronic Survivability*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	57.202	36.109	35.730	-	35.730	29.882	31.618	32.862	33.392	-	-
H16: *S3I Technology*	-	20.605	19.599	16.890	-	16.890	17.323	17.031	18.640	19.021	-	-
SA1: *Sensors and Electronic Initiatives (CA)*	-	20.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-
SA2: *Biotechnology Applied Research*	-	2.871	1.361	1.683	-	1.683	0.503	0.512	0.523	0.534	-	-
TS1: *Tactical Space Research*	-	5.578	6.702	7.032	-	7.032	2.611	4.444	3.875	3.812	-	-
TS2: *Robotics Technology*	-	8.148	8.447	10.125	-	10.125	9.445	9.631	9.824	10.025	-	-

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 H15 focuses on Combat Identification (CID) technologies, which include devices to locate, identify, track, and engage targets in the Joint fires environment. Project H16 investigates sensors, signal processing and information fusion technologies to increase target detection range and speed of engagement. 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 0603008A (Command Electronic Warfare Advanced Technology), PE 0603710A (Night Vision Advanced Technologies), and PE 0603772A (Advanced Tactical Computer Science and Sensor Technology),

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 Army Research Laboratory, Adelphi, MD and Aberdeen Proving Ground, MD; the Communications-Electronics Research, Development, and Engineering Center, Aberdeen Proving Ground, MD; and the United States (US) Army Space and Missile Defense Technical Center, Huntsville, AL.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army					Date: May 2017
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*			R-1 Program Element (Number/Name) PE 0602120A / *Sensors and Electronic Survivability*		
B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	58.374	36.109	32.972	-	32.972
Current President's Budget	57.202	36.109	35.730	-	35.730
Total Adjustments	-1.172	0.000	2.758	-	2.758
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.172	-			
• Adjustments to Budget Years	0.000	0.000	2.637	-	2.637
• Civ Pay Adjustments	0.000	0.000	0.121	-	0.121

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2016	FY 2017
Project: SA1: *Sensors and Electronic Initiatives (CA)*		
Congressional Add: *Program Increase*	12.500	-
Congressional Add: *Space and High Altitude Assets Survivability*	7.500	-
Congressional Add Subtotals for Project: SA1	20.000	-
Congressional Add Totals for all Projects	20.000	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / *Sensors and Electronic Survivability*	Project (Number/Name) H16 / *S3I Technology*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
H16: *S3I Technology*	-	20.605	19.599	16.890	-	16.890	17.323	17.031	18.640	19.021	-	-

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 battlespace 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 Program Element (PE) 0601104A (University and Industry Research Centers), PE 0602709A (Night Vision Technology), PE 0603710A (Night Vision Advanced Technologies), and PE 0603001A (Warfighter Advanced Technology). The networked sensing and data fusion efforts performed in this Project complement efforts funded in PE 0601104A / Project H50 (Network Sciences CTA) and PE 0601104A / Project J22 (Network Science and Technology Research Center CTA).

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

Work in this area is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Non-Imaging Intelligence, Surveillance, and Reconnaissance (ISR) Sensing	5.292	4.675	6.014
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			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** H16 / *S3I Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
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. ***FY 2016 Accomplishments:*** Developed advanced acoustic, magnetic- and electric-field sensors and arrays to detect and locate threats in complex environments; implemented algorithms to mitigate effects of acoustic propagation channel and signature modifications to optimize transient classification of mortar, rocket, gunfire and explosive events; applied electric and magnetic field phasor processing to detect and classify equipment and power events; and developed methods for detecting and classifying humans and human activities with multimodal image, video, and text data. ***FY 2017 Plans:*** Will develop sensor and processing algorithms to acoustically detect, track, and classify transients, vehicles, unmanned aerial systems (UAS), and infrasound sources, and integrate wind noise reduction and propagation error correction; develop electric- and magnetic-field phase measurements to extract target signatures in complex environments; develop sensors and methods to characterize device signatures and power events; and develop multi-modal processing algorithms to reliably detect targets in complex environments and under diverse environmental conditions. ***FY 2018 Plans:*** Will further improve acoustic and infrasound sensors and algorithms for detection, localization, tracking, and classification of air and ground platforms and transient weapon/explosive events; research geophysical/seismological sensing methods; will develop infrasound propagation data analysis, and a corresponding modeling/simulation capability; will develop acoustic techniques for locating of surface and subsurface events; will investigate and E/H fields from power-lines, electrical equipment, and Earth; will develop improved E/H-field sensors and algorithms; will improve size, weight, power and cost (SWaP-C) of monitoring nodes; provide persistent ISR and decision support capabilities to lower Army command echelons; will improve networked sensor coverage and probability of detection and false alarm rate with distributed processing and fusion techniques; will support information sharing and decision making and improve information density of sensor data streams; will improve Special Operations Command (SOCOM) mobility by developing (1) faster, quieter and more accurate Landing Zone assessment techniques with minimal over-watch and (2) a streamlined method of data input and analysis; and will characterize and assess technologies and sensor modalities that can detect and identify improvised explosive device systems and components that are buried or non-buried.			
Title: Networked Sensing and Data Fusion ***Description:*** This effort will develop and assess a concept to link physical sensors and information sources to Soldiers and small units. Specifically, the research focuses on (1) multi-modal sensor fusion for detection and classification of human activities and infrastructures such as personnel, vehicles, machinery, RF emissions, chemicals, and computers in hidden and confined spaces, (2) interoperability and networking of disparate sensors and information sources, (3) distributed information for decision-	3.626	5.506	5.137

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** H16 / *S3I Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
making, and (4) approaches for fusing results of processed outputs of multi-modal sensors, such as visible, infrared (IR), and hyperspectral imagers, and acoustic, magnetic, and electric field sensors. ***FY 2016 Accomplishments:*** Expanded tools to improve search capabilities of relevant social media data to fuse with sensor data; expanded interoperability for sensor plug-and-play capabilities and quick integration across unmanned sensors; designed algorithms that will exploit electric and magnetic field sensor fusion for electrical power event monitoring; and designed detection, tracking and cueing methodologies for counter-unmanned aircraft system (C-UAS) using fusion of acoustic, passive RF, and imaging modalities. ***FY 2017 Plans:*** Will research holistic approaches to networked sensor/data fusion by exploiting signatures in support of anti-personnel landmine alternatives (APL-A); research personnel and ground vehicle classification and anomaly determination algorithms using multi-modal sensors for robust, high confidence reports; research automatic human and vehicle activity classification in full motion video (FMV) and Wide Area Motion Imagery (WAMI); investigate a collaborative sensor environment to enhance data collection and collaborative design of fusion algorithms with the Army Cold Regions Research and Engineering Laboratory and the Air Force Research Laboratory. ***FY 2018 Plans:*** Will develop distributed processing and fusion algorithms that use shared decision-making processes over low-power, short-lifetime sensors with limited communication capabilities for efficient battlefield situational awareness to the dismounted Soldier; will develop sensor interoperability/integration standards to enable rapid cueing of coalition imaging and acoustic sensors for robust target classification; will develop robust methods to detect, classify, and track humans using networked, multi-modal sensing and fusion as an alternative replacement to anti-personnel landmines; will develop tools for creating and visualizing a multi-sensor three-dimensional (3D) common operating picture (COP) capable of performing real-time data geo-registration and fusion from multiple aerial and ground-based passive and active imaging sensors for increased situational awareness; and will develop tools for biometric and human activity recognition from video feeds.			
Title: RF Sensing for Concealed/Low-Signature Threat Detection (previously Ultra Wideband (UWB) Radar) ***Description:*** This effort develops the technical underpinnings of 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, 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.	3.419	1.794	2.713

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** H16 / *S3I Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
FY 2016 Accomplishments: Investigated utility of combining forward looking radar with electro-optical/infrared (EO/IR) sensor to improve detection and reduce false alarms for standoff detection of explosive hazards; incorporated stereo visible cameras to provide three-dimensional reconstruction of the environment that can be fused with radar image formation algorithms; and investigated and validated disturbed earth computational UWB forward-looking radar models. ***FY 2017 Plans:*** Will collect and assess new UWB stepped-frequency, radar standoff explosive hazard detection data sets to address radio frequency interference, clutter mitigation, and self-interference in relevant environments; combine and assess data with electro-optic/IR standoff detection sensor data sets to further reduce false-alarms associated with explosive hazard threat deployments; exploit two-dimensional (2D) and 3D reconstruction of the environment across standoff sensors and algorithms for improved performance; and develop exploitation algorithms for detection and discrimination of explosive hazards relating to forward-looking standoff radar. ***FY 2018 Plans:*** Will incorporate passive RF sensing modality with UWB radar to improve detection of electronic targets (e.g., radio controlled triggers); will assess performance of combined forward-looking sensors against relevant threat; develop a lightweight UAS-compatible RF sensor with equivalent sensitivity to a vehicle-mounted stepped frequency radar in order to increase standoff protection beyond the blast radius; will investigate an adaptive and learning (i.e., cognitive) electronic front-end that can be incorporated with a UWB radar that will improve operations in congested and contested RF environments; and will utilize low-cost software-defined radio (SDR) technology and 2D antenna arrays to detect, geo-locate, and track aerial- and ground-based electronic threats.			
Title: Laser Protection Technologies (previously Networked Compact Radar, Wide Bandgap Optoelectronics, and Laser Protection Technologies) ***Description:*** This effort develops new materials and devices for the protection of Army sensors and eyes behind day-view optical sights from a variety of laser threats including high-power continuous wave and ultrashort (femto-second) pulsed lasers. This research utilizes a combination of technologies based on the nature of the different threats, as well as the fundamental 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. ***FY 2016 Accomplishments:***	2.940	3.757	2.957

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** H16 / *S3I Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Studied and characterized non-linear optical materials (including two novel platinum bipyridine complexes and several iridium dyes) for eye and camera protection on mounted ground vehicle platforms and investigated active long wavelength protection filters for uncooled infrared cameras and focal plane arrays to reduce their vulnerability to damage and dazzle. ***FY 2017 Plans:*** Will develop exploitation algorithms for detection and discrimination of explosive hazards relating to forward-looking standoff radar, design distributed and decentralized algorithms using consensus methods of networked sensors for a moving ground vehicle, and determine the improvement in ground vehicle tracking accuracy and efficiency versus conventional centralized approaches; research advanced active protection techniques and new non-linear optical materials based on results for bipyridine and iridium dye experiments, to increase protection against laser-induced damage of eyes and cameras in wavelength ranges from visible through shortwave IR; perform studies and create UV sources (e.g., light-emitting diodes and lasers) with output power greater than 20 mW in the wavelength range of 200-290 nm, and photodetectors with single-photon detection capability across the ultra violet (UV) spectral range for Army applications including water sterilization, non-line-of-sight communications, and chemical-biological detection. ***FY 2018 Plans:*** Will investigate the use of short-pulsed (femto-second) optical limiting materials to prevent sensor damage, and determine if some of the secondary destructive effects of these types of pulses can be mitigated; will develop and test solid material limiters for nanosecond to microsecond threats and compare their performance to liquid material limiters; and will explore advanced concepts to protect optical systems, both visible and IR, from high-power continuous wave lasers.			
Title: Multi-Mode Air Defense Radar ***Description:*** This research supports the current and future technical challenges associated with air defense radar technology. In particular, this effort will analyze current and emerging RF spoofing, RF jamming, and RF signature management technologies to determine their impact on the performance of air defense radars. Electromagnetic modeling, RF measurements, and experiments will be used to identify mitigation techniques for spoofing and jamming, and to identify useful signature management technologies. This will also include research in electronic devices, sub-assembly design, and laboratory experiments to advance the state-of-the-art of air defense radars operating in contested electronic environments. ***FY 2016 Accomplishments:*** Modeled air targets to investigate multiband architectures, alternative spectrum configurations, and broadband apertures; investigated spectrum sensing algorithms specific to air defense radar bands (e.g., L-band thru X-band and beyond); and investigated novel tracking algorithms for rockets, artillery, and mortar targets for next generation air defense radar. ***FY 2017 Plans:***	5.328	3.867	0.069

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** H16 / *S3I Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will design and characterize multiband elements with integrated front-end radar components including the amplifier and mixer; validate electromagnetic models of both target and physical phenomenology; extract radar architecture and circuit requirements from assessments and simulations; and emulate cognitive algorithms for electronic protection in a contested RF environment. ***FY 2018 Plans:*** Will finalize and document electromagnetic modeling results, advanced circuit designs, and cognitive algorithm development work.			
Accomplishments/Planned Programs Subtotals	20.605	19.599	16.890

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / *Sensors and Electronic Survivability*	Project (Number/Name) SA1 / *Sensors and Electronic Initiatives (CA)*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
SA1: *Sensors and Electronic Initiatives (CA)*	-	20.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Sensors and Electronic Initiatives.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017
Congressional Add: Program Increase ***FY 2016 Accomplishments:*** This is a Congressional Interest Item	12.500	-
Congressional Add: Space and High Altitude Assets Survivability ***FY 2016 Accomplishments:*** This is a Congressional Interest Item	7.500	-
Congressional Adds Subtotals	20.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / *Sensors and Electronic Survivability*	Project (Number/Name) SA2 / *Biotechnology Applied Research*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
SA2: *Biotechnology Applied Research*	-	2.871	1.361	1.683	-	1.683	0.503	0.512	0.523	0.534	-	-

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) 0601104/H05, Institute for Collaborative Biotechnologies (ICB) University Affiliated Research Center (UARC), 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 ICB 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 Assistant Secretary of Defense, Research and Engineering Science and Technology priority focus areas.

Work is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Biotechnology Applied Research	2.871	1.361	1.683
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.			
FY 2016 Accomplishments: Tested hybrid biofuel cells; developed and tested assays with advanced protein capture agents to validate capability to rapidly respond to emerging threats; evaluated bio-inspired algorithms for control applications including decision support tools to unburden unmanned aerial vehicle (UAV) operators; and conducted field evaluation of combined bio-inspired algorithms for distributed mobile gunfire detection.			
FY 2017 Plans: Will evaluate microbial communities for the generation of fuel for bio-hybrid fuel cells that can accept multiple types of fuel; develop, integrate, and assess pairs of advanced capture agents for threat materials and evaluate assays to validate capability to rapidly respond to emerging threats; evaluate bio-inspired algorithms for control applications including decision support tools			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** SA2 / *Biotechnology Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
for mounted soldiers; develop experimental platforms to evaluate bio-inspired protocols to unburden the cognitive load on UAV operators; and complete analysis of combined bio-inspired algorithms for distributed mobile gunfire detection. ***FY 2018 Plans:*** Will integrate microbial communities for the conversion of waste and indigenous feedstocks or simulants to chemicals useful for waste-to-energy systems and starting materials for agile materials synthesis; will integrate biological and non-biological components to convert waste and indigenous feedstocks to chemicals potentially useful for bio-hybrid fuel cells, and evaluate them for transition to waste-to-energy / alternative energy development programs; and will investigate components of a high-throughput platform for on-demand assay development for robust biosensor reagents.			
Accomplishments/Planned Programs Subtotals	2.871	1.361	1.683

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / *Sensors and Electronic Survivability*	Project (Number/Name) TS1 / *Tactical Space Research*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
TS1: *Tactical Space Research*	-	5.578	6.702	7.032	-	7.032	2.611	4.444	3.875	3.812	-	-

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 Program Element (PE) 0603006A (Space Applications Technology).

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Warfighting Challenges.

Work in this Project is performed by the Army Space and Missile Defense Command/Army Forces Strategic Command (SMDC/ARSTRAT) in Huntsville, AL.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Tactical Space Research	4.557	5.664	5.921
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.			
FY 2016 Accomplishments: Investigate and develop network hardware and software interfaces and information dissemination architecture that allows Software Defined Radio (SDR) and imagery payloads to be controlled from any node and products distributed to tactical ground units; develop follow-on small satellite antenna and guidance, navigation, and control (GNC) components that have less mass, are more accurate, and are more power efficient; and investigate technologies and explore collaboration opportunities with other Services and Agencies for small satellite affordable launch capabilities.			
FY 2017 Plans: Will design and develop small satellite components to support the Army's Warfighter Information Network – Tactical (WIN-T); develop data processing algorithms and network integration interfaces to improve Army tracking and locating capabilities for			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** TS1 / *Tactical Space Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
ground objects of interest; investigate satellite-to-satellite communications components to reduce forward-deployed ground control station requirements by enabling control of beyond-line-of-sight satellites and continue to explore collaboration opportunities with other Services and Agencies for small satellite affordable launch capabilities. ***FY 2018 Plans:*** Design and develop small satellite components to support the Army's multi-band beyond-line-of-sight (BLOS) and on-the-move comms for disadvantaged users; refine data processing algorithms and define network integration interfaces to improve Army tracking and locating capabilities for ground objects of interest; initial accreditation of network used to verify satellite command and control capabilities and conduct experiments with on orbit demonstration satellites, as well as incremental advances in capabilities to incorporate additional science and technology (S&T) satellite technology efforts; and continue to monitor collaboration opportunities with other Services and Agencies on small satellite and affordable launch capabilities.			
Title: Space and Analysis Lab ***Description:*** This effort provides an in-house capability to design and conduct analytic evaluations of space and high altitude technologies. ***FY 2016 Accomplishments:*** Developed components for follow-on small satellite designs, to include propulsion and distributed aperture imager components. ***FY 2017 Plans:*** Will continue small satellite design and assess capabilities through the use of in-house distributed bench assessment and Hardware In The Loop capabilities. ***FY 2018 Plans:*** Complete the development of experimental small satellite payloads and prepare for integration on flight vehicle; validate capabilities through the use of in-house distributed bench assessment and Hardware In The Loop capabilities.	1.021	1.038	1.111
Accomplishments/Planned Programs Subtotals	5.578	6.702	7.032

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** TS1 / *Tactical Space Research*

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / *Sensors and Electronic Survivability*	Project (Number/Name) TS2 / *Robotics Technology*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
TS2: *Robotics Technology*	-	8.148	8.447	10.125	-	10.125	9.445	9.631	9.824	10.025	-	-

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 Program Element (PE) 0601104A/Project H09.

This Project sustains Army Science and Technology efforts supporting the Air and Ground Maneuver portfolios.

This Project leverages basic research conducted under PE 0601102A/Project T63 (Robotics Autonomy, Manipulation and Portability) and PE 0601104A/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 Assistant Secretary of Defense for Research and Engineering Science and Technology focus areas, and the Army Modernization Strategy.

Work in this Project is performed by the Army Research Laboratory (ARL) at the Aberdeen Proving Ground, MD, and the Robotics Collaborative Technology Alliance consisting of Carnegie Mellon University, Florida State University, General Dynamics Robotics Systems, Jet Propulsion Laboratory, QinetiQ North America, University of Central Florida, and University of Pennsylvania.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Robotics CTA	3.512	3.811	4.023
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 populated environments and minimize the cognitive workload on Soldier operators enabling more dexterous manipulation of objects.			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** TS2 / *Robotics Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
FY 2016 Accomplishments: Instantiate enhanced hybrid cognitive architecture on robots to explore teaming behaviors including natural modes of communication and control in the context of a mixed small unit; incorporate mechanisms and software to permit robots to effectively perform basic manipulation skills; integrate resultant technology into test bed platforms to assess technology maturity. The hybrid architecture permits command and communication to be at a natural or abstract level similar to a Soldier issuing a command (e.g., open the third door on the right) to a subordinate. ***FY 2017 Plans:*** Will incorporate advanced algorithms for reasoning, learning, and multi-modal communication between human and robot into existing architecture and conduct virtual and live experiments to determine limits of performance; expand implantation of the architecture for whole body manipulation that efficiently utilizes interaction with objects in an environment to mimic capabilities of biological systems. ***FY 2018 Plans:*** Will instantiate full capability for an unmanned ground robot Talon and below size) to conduct a simplified, yet realistic military mission at less than human operational speed, including perceptual, mobility, and manipulation capabilities. ARL plans on near-field recognizance to demo technology with applicability to multiple Research, Development and Engineering Center (RDEC) demos for ground platforms (e.g, convoy operations, tactical logistics, Intelligence, Surveillance, and Reconnaissance (ISR)). Will conduct a performance assessment with the aim of transition to concept demonstrations conducted by an Army Research, Development and Engineering Center (RDEC).			
Title: Perception and Intelligent Control	4.636	4.636	4.640
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. ***FY 2016 Accomplishments:*** Continued extension of perceptual, reasoning, and learning techniques for unmanned systems to enable creation of a common, though not necessarily equivalent, mental model of the surrounding world facilitating planning and execution of tasks, as well as communication with human teammates; and conducted experiments focused upon establishing technology maturity and performance gaps. ***FY 2017 Plans:***			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** TS2 / *Robotics Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will incorporate initial perceptual, reasoning, and learning capabilities into a comprehensive architecture and conduct both virtual and live experiments; explore concepts for whole body manipulation and hybrid mobility modes in simulation and live experimentation; instantiate intelligent control architecture into appropriate virtual environment and on appropriate surrogate unmanned air and ground systems; and explore initial behaviors for manned-unmanned teaming and for manipulation of objects by unmanned air and ground systems. ***FY 2018 Plans:*** Will expand the perceptual, reasoning, and learning capabilities into a comprehensive architecture and conduct experimentation. Will utilize a cognitive construct for abstract reasoning to more effectively integrate individual perceptual algorithms together with contextual information.			
Title: Ground Robotic Vehicle Mobility and Propulsion Technology ***Description:*** Advance the speed and agility of unmanned vehicles in complex three-dimensional environments through exploration of advanced and unconventional mobility and propulsion technologies integrated with innovative application of perceptual and reasoning capabilities. Ground robotic platforms may have legs, may be able to climb or may even be robots restricted to small confined spaces. Research will focus on developing actuation mechanism that intelligently achieve movement while minimizing the use of energy to ensure longer range and endurance of the system. ***FY 2018 Plans:*** Will explore hybrid modes of mobility to enable energy efficient mobility at operational tempo.	-	-	1.462
Accomplishments/Planned Programs Subtotals	8.148	8.447	10.125

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602122A / *TRACTOR HIP*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	6.879	6.995	8.627	-	8.627	8.674	9.319	9.467	9.619	-	-
622: *D622*	-	2.396	2.275	3.823	-	3.823	3.840	4.390	4.439	4.488	-	-
B72: *AB72*	-	4.483	4.720	4.804	-	4.804	4.834	4.929	5.028	5.131	-	-

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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	6.879	6.995	7.120	-	7.120
Current President's Budget	6.879	6.995	8.627	-	8.627
Total Adjustments	0.000	0.000	1.507	-	1.507
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	0.000	0.000	1.500	-	1.500
• Civ Pay Adjustments	0.000	0.000	0.007	-	0.007

Change Summary Explanation

FY 2018 - Classified Program funds increase.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army											Date: May 2017	
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 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
622: *D622*	-	2.396	2.275	3.823	-	3.823	3.840	4.390	4.439	4.488	-	-

A. Mission Description and Budget Item Justification

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

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army											Date: May 2017	
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 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
B72: *AB72*	-	4.483	4.720	4.804	-	4.804	4.834	4.929	5.028	5.131	-	-

A. Mission Description and Budget Item Justification

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

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602211A / *Aviation Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	58.497	65.914	66.086	-	66.086	61.846	63.583	63.915	65.222	-	-
47A: *AERON & ACFT Wpns Tech*	-	50.205	56.159	55.630	-	55.630	51.119	52.642	52.680	53.756	-	-
47B: *Veh Prop & Struct Tech*	-	8.292	9.755	10.456	-	10.456	10.727	10.941	11.235	11.466	-	-

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 Assistant Secretary of Defense for Research and Engineering S&T focus areas and the Army Modernization Strategy. Work in this PE is performed by the Army Aviation and Missile Research, Development, and Engineering Center (AMRDEC), located at Redstone Arsenal, AL; Joint Base Langley Eustis, VA; National Aeronautics and Space Administration (NASA) Ames Research Center, Moffett Field, CA; NASA Langley Research Center, Hampton, VA; and at the Army Research Laboratory (ARL), located at Adelphi, MD; Aberdeen Proving Ground, MD; Hampton, VA; and Cleveland, OH.

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	56.884	65.914	65.902	-	65.902
Current President's Budget	58.497	65.914	66.086	-	66.086
Total Adjustments	1.613	0.000	0.184	-	0.184
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	3.700	-			
• SBIR/STTR Transfer	-2.087	-			
• Civ Pay Adjustments	0.000	0.000	0.184	-	0.184

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
47A: *AERON & ACFT Wpns Tech*	-	50.205	56.159	55.630	-	55.630	51.119	52.642	52.680	53.756	-	-

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 Program Element (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 Assistant Secretary of Defense for Research and Engineering Science and Technology focus areas and the Army Modernization Strategy.

Work in this Project is performed by the Aviation Development Directorate of the Army Aviation and Missile Research, Development, and Engineering Center (AMRDEC), (located at the NASA Ames Research Center, Moffett Field, CA, NASA Langley Research Center, Hampton, VA; and Joint Base Langley Eustis, VA).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: National Rotorcraft Technology Center (NRTC)	4.524	4.686	-
Description: NRTC focuses government, United States (U.S.) rotorcraft industry, and academia resources on the development of pre-competitive, high-priority, military technology to maintain U.S. preeminence in rotorcraft capabilities.			
FY 2016 Accomplishments: Conducted industry-collaborative research in rapid certification of complex aviation systems; extreme reliability; structural integrity; aeromechanics modeling, design, and analysis of complex systems; advanced vehicle management systems and controls; component design and analysis tools; and design of transmission and drives component technology for reduced rotorcraft procurement and sustainment costs.			
FY 2017 Plans:			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
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 2016	FY 2017	FY 2018
Will conduct industry-collaborative research in extreme reliability of aviation systems; structural integrity; aeromechanics modeling, design, and analysis of complex systems; advanced vehicle management systems and controls; component design and analysis tools; cargo handling and delivery; advanced aircraft mission systems; naval operations; and design of transmission and drives component technology for reduced rotorcraft procurement and sustainment costs.			
Title: Rotors & Vehicle Management Technologies	9.066	10.795	10.864
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. ***FY 2016 Accomplishments:*** Developed and assessed high-fidelity computational models of complete rotorcraft for the aerodynamics and dynamics in both straight and level and maneuver flight. Completed last phase of downwash/outwash flow field beneath a sub-scale rotor in hover parametric study to refine current physical understanding of the complex, non-linear, coupled, downwash/outwash interactional flow field and enabled refinement of modeling and simulation tools using measured downwash/outwash data. Developed innovative diagnostic techniques to measure and improve understanding of interactional aerodynamic phenomena. Integrated rotors and vehicle management system technologies to reduce rotor loads, reduce hub and airframe drag and improve vehicle performance. Conducted flight experiments of dual-lift flight control. Integrated flight control and handling qualities analysis into Army preliminary design tools and NASA Design and Analysis of Rotorcraft (NDARC) for advanced rotorcraft configurations. Conducted piloted handling qualities experiments toward new/revised ADS-33 quantitative and qualitative criteria to address advanced rotorcraft concepts and missions supporting the Future Vertical Lift (FVL). ***FY 2017 Plans:*** Will apply and explore next generation airfoils, active flow control concepts, and advanced rotors and VMS technologies in benchtop, sub-scale and full-scale experiments to improve the current physical understanding of interactional aerodynamics to enable adverse force reduction necessary for high speed forward flight. Will refine models and simulations relevant to advanced high speed, lift offset, and compound configurations. Will continue development of innovative diagnostic techniques to measure and improve understanding of interactional aerodynamic phenomena. Will continue to improve the accuracy and efficiency of high-fidelity computational fluid dynamics simulations on high-performance parallel computers; software will be optimized to efficiently scale on thousands of processors and new heterogeneous parallel computer hardware architectures; will develop new computational methods to automate the computational mesh generation and computational fluid dynamics solutions relevant to advanced aerodynamic vertical lift configurations. Will publish validated flight control analysis, design, and optimization methods in the open literature. Will extend Modernized Control Laws (MCLAWS) with mission adaptive autonomy (MAA). Will refine and update flight control design methods and tools (CIFER, CONDUIT, RIPTIDE) as needed to support advanced high-speed			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
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 2016	FY 2017	FY 2018
configurations. Will revise/develop ADS-33 criteria for advanced high-speed configurations and missions based on Joint Multi-Role Technology Demonstrator (JMR TD) lessons learned. ***FY 2018 Plans:*** Will improve the accuracy and efficiency of high-fidelity computational fluid dynamics simulations on high-performance parallel computers including rotors and vehicles with active flaps, active flow control, and morphing surfaces; evaluate and optimize computational execution efficiency software on new heterogeneous parallel computer hardware architectures. Will conduct sub-scale testing of an advanced rotor design; will conduct benchtop and sub-scale testing of passive and active flow control concepts. Will analyze JMR TD flight test data to assess and improve government simulation modeling methods for advanced configurations. Will apply advanced control allocation methods to a piloted simulation based on a JMR TD configuration. Will study flight control and handling-qualities issues associated with an advanced wing-compound configuration.			
Title: Aircraft and Occupant Survivability Technologies ***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 2016 Accomplishments:*** Developed and evaluated composite armor integrated into primary load bearing structure systems to improve conventional threat protection while reducing overall system weight. Evaluated passive and active energy attenuating devices integrated into primary structure to improve crashworthiness while reducing overall system weight. Conducted ballistic and crash experiments on lightweight composite armor components and energy attenuating devices to verify performance. Developed next generation ballistic, crash, and directed energy weapon protection and fuel containment technologies. ***FY 2017 Plans:*** Will evaluate application of advanced systems/subsystems and configurations that provide lightweight, high performance threat protection against non-conventional weapons to include directed energy. Will continue to develop and evaluate active crash protection and crashworthy ballistic tolerant fuel containment systems for full spectrum crashworthiness. Will continue to evaluate holistic survivability technology solutions through integrated survivability assessment trade studies for FVL concept aircraft. These trades will include multi-layered survivability concepts with seeker/guidance agnostic technologies to address operations in the emerging threat environment. Will develop hardware, integrate, and investigate adaptive engine exhaust suppressor systems on an engine test stand to evaluate infrared (IR) signature and engine performance of the integrated system. ***FY 2018 Plans:*** Will continue development of next generation advanced composite lightweight armor. Will continue development of next generation lightweight ballistic tolerant crashworthy fuel containment systems. Will continue development of crashworthiness subsystem devices that build on advanced crash protection concepts previously developed. Initiate development of advanced fire	4.320	6.095	6.607

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
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 2016	FY 2017	FY 2018
management subsystems. Will continue development of adaptive IR engine suppressor system to optimize aircraft performance and IR signature. Will continue to develop signature management technologies.			
Title: Engine and Drives Technologies	3.461	6.608	6.683
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 ***FY 2016 Accomplishments:*** Performed the conceptual design and determined the benefits of advanced integrated engine controls technologies such as distributed controls and more electric controls for improved aviation system engine performance, weight, and maintainability; developed design of a smart, adaptable, and efficient sand filtration system for improved engine performance and durability; and designed drive train technologies with multi-speed (ability to vary shaft speed between 50 and 100%) to support development of next generation rotorcraft transmission and FVL objectives. ***FY 2017 Plans:*** Will finalize the design of the smart, adaptable, and efficient sand filtration technology for improved engine performance and durability and begin fabrication of hardware for validation test; will investigate alternative adaptable engine architectures/ components in support of alternative concept engine and FVL objectives; will validate through experimentation drive train component technologies with multi-speed (ability to vary shaft speed between 50 and 100%) in support of next generation rotorcraft transmission and FVL objectives. ***FY 2018 Plans:*** Will complete validation testing of smart, adaptable, and efficient sand filtration technology for improved engine performance and durability; complete investigation of alternative adaptable engine architectures in support of high performance alternative concept engine; investigate of alternative adaptable engine components in support of high performance alternative concept engine and FVL objectives; continue validation through experimentation drive train component technologies with multi-speed (ability to vary shaft speed between 50 and 100%) in support of next generation rotorcraft transmission and FVL objectives.			
Title: Platform Design & Structures Technologies	7.047	6.322	11.151
Description: Enables new rotorcraft configurations by evaluating critical advanced 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			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
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 2016	FY 2017	FY 2018
system reliability. Work is coordinated with Aviation Component Failure Modeling efforts in PE 0602211, Project 47B at Army Research Laboratory (ARL). ***FY 2016 Accomplishments:*** Continued enhancement of the Integrated Design Environment (IDE) for conceptual design of advanced rotary wing concepts with the addition of methodologies for airfoil design, signatures, operational impact of downwash/outwash, stability & control, and design optimization and sensitivity analysis. Applied modeling and simulation tools to support design of FVL/novel concepts and analysis of their operational feasibility. Enhanced probabilistic structural integrity and useful life analytical techniques through improved damage initiation and propagation models; developed and performed investigation of high-strain capable, multifunctional structures that offer improvements in structural efficiency and enable ultra-reliable, operationally durable designs. ***FY 2017 Plans:*** Will continue to develop and mature robust analyses that use integrated physics and probabilistic based methods to assess and manage structural integrity; verify the performance of operationally durable airframe technologies and designs. Will begin integration of total survivability features into ultra-reliable, multifunctional structures to include multifunctional structural armor and crash protection solutions. Will facilitate maturation of IDE. ***FY 2018 Plans:*** Will investigate and validate modeling and design tools to support development of future unmanned aerial vehicles. Will conduct in-house and industry research in support of Next Generation Tactical Unmanned Aircaft Systems (NGTUAS) and other manned and unmanned aircraft concepts; will develop a draft Model Performance Specification (MPS) for NGTUAS. Will verify performance of multifunctional structures technologies for survivability though analysis and incremental testing; will continue to mature probabilistic based stress and service life analyses; will investigate advanced structural design and manufacturing techniques, including optimized smart structures and fastener-free joining methods. Will initiate development of advanced damage tolerant electromechanical actuators to replace current generation hydraulic systems. Will initiate development of energy optimized platform concepts and subsystems intended to maximize electric power availability while managing overall platform thermal loading and minimizing system level space, weight, and power burdens.			
Title: Unmanned and Optionally Manned Technologies ***Description:*** Design and develop collaboration and cooperation algorithms to support goal of intelligent teaming for manned-unmanned operations. Design and develop advanced unmanned aircraft system (UAS) components to support goal of improved small UAS performance. When applicable, technologies in this area are leveraged to support mitigation of degraded visual environments (DVE). ***FY 2016 Accomplishments:***	6.345	6.909	6.446

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
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 2016	FY 2017	FY 2018
Investigated optimal human-machine visual, aural, and tactile interfaces for manned-unmanned teaming that support efficient mission execution and safe flight operations with high situational awareness for pilots and unmanned aerial system operators. Optimized plan-view and forward-looking synthetic and enhanced vision sensor information with symbology, aural, and haptic cueing that aids the helicopter pilot or operator in control of the helicopter in complex environments. Included close proximity flight in a simulation environment and developed technology for a simulation experiment. Developed data fusion technologies of both on and off board sensors in a simulation environment. ***FY 2017 Plans:*** Will develop algorithms for increased autonomy applicable across a range of UASs including autonomous flight controls, behaviors to support tactical missions, open architectures, and contingency management to support mission execution independent of a constant data link to a ground control station. Improvements to autonomous flight controls will support more reliable, more robust flight operations independent of a human operator or pilot, and enable improved mission capable UAS flight operations. Will develop integration approaches between emerging multi-national open architecture frameworks and interfaces. The open architecture approach is a key enabling technology to rapidly develop and transition new autonomous concepts. ***FY 2018 Plans:*** Will mature autonomous flight control algorithms to support optionally manned helicopter flight operations. Design and develop tube launched UAS components to support manned unmanned teaming (MUM-T) of UAS with both manned and unmanned ground vehicles, building towards an UASs on-demand capability. Investigate system software and hardware architectures to make autonomous systems more resilient and adaptable to mission changes and system failures. Investigate multi modal cueing for increased situational awareness in all domains. Investigate management of aircrew workloads throughout mission execution, to include MUM-T.			
Title: Aircraft Weapon & Sensor Technologies ***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. ***FY 2016 Accomplishments:*** Developed sensor integration architecture and networking standards to enable the capability to quickly and easily integrate sensor systems on to Army aircraft, and to enable more seamless sensor and imaging data fusion. Conducted lab based sensor networking and experimentation to verify the enhanced sensor integration and fusion capabilities. Conducted a Common Gun study to determine the requirements and feasibility of a common gun system on FVL, Apache, and other Army aircraft systems, operating across a range of missions. Continued to support AMRDEC Missile PE 0603313A, and Communications and Electronics Research, Development, and Engineering Center (CERDEC) Night Vision and Electronic Sensors Directorate	1.543	1.625	1.659

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
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 2016	FY 2017	FY 2018
(NVESD), PE 0603710A for the design and development of an organically launched sensor system that will be deployed from Army aircraft with a wide range of sensing capabilities. ***FY 2017 Plans:*** Will investigate image integration techniques for use in target location to reduce the sensor to shooter timeline and improve lethality. Will investigate using current on-board sensors and advance weapons techniques to assess the potential supplement as an active protection system. ***FY 2018 Plans:*** Will define, develop and evaluate concepts for acquiring, storing, preparing, exploiting and distributing sensor data to enhance situational awareness, reduce crew workload and increase mission effectiveness. Will refine the components required for launching organic payloads off of aircraft wingstores. Evaluate several air-to-air targeting algorithms intended to support advanced threat protection and counter UAS.			
Title: Maintainability & Sustainability Technologies ***Description:*** Develop prognostic and system health assessment technologies to enable an enhanced Condition Based Maintenance (CBM) supportability structure and posture for application towards an ultra-reliable, low maintenance design approach that significantly reduces unscheduled maintenance, inspections and operations and sustainment costs. ***FY 2016 Accomplishments:*** Investigated use of wireless communication technologies to reduce wiring weight associated with prognostics and diagnostics; Integrated health assessment technologies into Joint Common Architecture (JCA)/avionics/cockpit; developed fly-by-wire (FBW) with CBM monitoring capability; Developed miniaturized wireless sensors with on-component processing, history and parts tracking; Developed improved fleet management capability with autonomous logistics for parts/production control; Investigated technologies for in-flight data transmission to ground. ***FY 2017 Plans:*** Will perform investigation of technologies and methodologies to enable more efficient designs and reduce the maintenance burden for future and current fleet of vertical lift aircraft. Will perform experiments of on-engine, adaptive engine controls to optimize performance, component life and maintenance schedule based on engine health. Will begin investigation of in-flight, real-time, automated methods to adjust rotor system track and balance to reduce aircraft vibration and loads. Will investigate improved failure detection within a planetary system, reduced size and weight impact of advanced sensor technologies, and a methodology to allow operations above maximum continuous rating for limited periods of time. Will investigate a proper level of autonomy to the condition assessment process for a composite airframe and provide decision support for repair decisions with a repair integrity assessment approach. Will continue development of a comprehensive integrated aircraft wide electrical system capability for	2.022	3.619	3.695

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
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 2016	FY 2017	FY 2018
diagnostics, fault isolation, and generate trendable health indicators. Will continue investigation of reliability criteria for design tools, methodologies, and materials to facilitate the optimization of future rotorcraft designs. ***FY 2018 Plans:*** Will investigate efforts to improve component prognostics capability for aviation systems. Investigate sensor and maintainability technologies that enable improved prognostics for an improved and integrated aircraft system health monitoring and management capability. Will identify improved materials and processes that enhance system durability and reliability. Will determine fleet and logistics management data interface and transfer gained knowledge.			
Title: Survivability For Degraded Visual Environment (DVE) Operations ***Description:*** Research advanced sensor and cockpit display technologies to provide ability to maintain terrain and obstacle situational awareness during aircraft induced (brown-out & white-out) and environmentally induced (rain, snow, smog, fog, smoke, low light, etc.) DVE. Work in this area is being done in coordination with efforts at Army CERDEC, PE 603710A, Night Vision Advanced Technology. ***FY 2016 Accomplishments:*** Executed a second iteration of experimentation at United States Army Aeromedical Research Laboratory (USAARL) simulation facility (Fort Rucker, AL) focusing on symbology, tactile and aural technologies trades and optimization. Continued software algorithm and materiel component design and development for execution of sensor fusion involving laser detection and ranging (LADAR), radio detection and ranging (RADAR) and IR systems for two separate DVE Mitigation Program lines of effort. Executed system integration design and substantiation of two multi-modality sensor fusion packages; this includes mechanical, electrical and instrumentation packages, a "best of breed" symbology set for all modes of flight (landing, take-off, enroute), and appropriate advanced cueing tactile and aural elements that were identified in USAARL simulator experiments. ***FY 2017 Plans:*** Will continue experimentation and development of MCLAWS to incorporate capability developments such as coupled flight, power management guidance, and sensor coupled optionally piloted flight. Will continue complex computing design studies to determine best open systems architecture to handle processing power requirements, data rates, and latency while retaining interface to existing and future architectures. Will complete two software algorithm and materiel component design and development lines of effort. Will develop sensor fusion efforts involving LADAR, RADAR & IR systems for Fiscal Year (FY) 2020 milestone DVE-M flight demonstration. Will refine a "best of breed" symbology set for all modes of flight (take-off, enroute, landing), and appropriate advanced cueing tactile and aural elements that were identified in USAARL simulator experiments; will develop intuitive cueing system that provides spherical situational awareness. ***FY 2018 Plans:***	8.177	9.500	8.525

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
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 2016	FY 2017	FY 2018
Will initiate MCLAWS Version 5 (V5) development; MCLAWS V5 will be the updated flight control laws for U.S. Army helicopters. Begin to incorporate laboratory modeling and reconfiguring of Obstacle Field Navigation (OFN) and Safe Landing Area Determination (SLAD) into MCLAWS V5.			
Title: Congressional Add - Flight Controls ***FY 2016 Accomplishments:*** This is a congressional add that was moved from the Navy to the Army to fund applied research in flight controls to reduce pilot workload	3.700	-	-
Accomplishments/Planned Programs Subtotals	50.205	56.159	55.630

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
47B: *Veh Prop & Struct Tech*	-	8.292	9.755	10.456	-	10.456	10.727	10.941	11.235	11.466	-	-

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 handheld 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 Program Element (PE) 0603003A (Aviation Advanced Technology) and leverages basic research performed in PE 0601104/Project H54 (Micro Autonomous Systems Technology Collaborative Technology Alliance) and PE 0601104/Project H09 (Robotics Collaborative Technology Alliance).

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

Work in this Project is performed by the Army Research Laboratory (ARL) at the National Aeronautics and Space Administration (NASA) Glenn Research Center, Cleveland, OH, the NASA Langley Research Center, Hampton, VA, and the Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Rotor and Structure Technology	2.483	2.589	2.340
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.			
FY 2016 Accomplishments: Design and develop smart materials that can self-sense, self-heal and self-reconfigure to facilitate damage/health assessment of aviation component structures; evaluate material/component damage sensing strategies; conduct modeling and simulation of damage detection; and investigate data fusion techniques for assessing material/component failure in aircraft.			
FY 2017 Plans: Will capture material damage precursors using test coupons in a laboratory environment for aircraft structural materials; develop a computational tool to calculate the optimum flight path of multi-rotor rotorcraft in auto-rotative flight, and validate the predictions of the tool by comparing to higher-fidelity methods for steady autorotation or empirical measurements to establish fast engineering computational tools to examine and advance optimum flight paths for next generation Army rotorcraft; use established co-axial			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47B / *Veh Prop & Struct Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
computational model(s) to assess technologies, including active flow control, structural shape morphing, and blade pitch control, for potential increase in maximum flight speed with the same safety margins; apply models to assess performance improvement. ***FY 2018 Plans:*** Will develop an efficient computational, structural fatigue method to predict the growth of small cracks or even earlier material damage indicators relevant to Army aviation; will conduct experiments to verify the fatigue method and improve the accuracy predictions for remaining structural fatigue life. Will develop a computational model of a co-axial rotor system to understand the fundamental interactions between counter-rotating rotors and their effects on transient hub loads and rotor blade defections.			
Title: Air Vehicle Propulsion and Power Technology (previously tittled: Engine and Drive Train Technology) ***Description:*** Applied research investigating engine and drivetrain technologies for Army manned-and-unmanned air vehicles. Research, investigates, and conducts experiments to develop, innovate, and validate advanced models and improved methods for propulsion system components and configurations to enable improvements in power density, efficiency, reliability and life cycle cost for increasing performance and capabilities of Army aviation systems. ***FY 2016 Accomplishments:*** Investigated coupled physics-based probabilistic design of ultra-lightweight hybrid gear; validated component modeling on extended design space for variable-speed turbine; and investigated novel micro injector technology for UAS engines using both analysis and modeling to mature optimization tools for efficient fuel combustion to increase UAS mission capabilities. ***FY 2017 Plans:*** Will investigate the performance of an ultra-lightweight hybrid gear under simulated load conditions and compare it with state-of-the-art metal gears to assess its potential applicability to future Army vertical lift vehicles; investigate the potential of a new class of high temperature shape memory alloys and other active and passive smart materials to enable shape changing turbine airfoils to allow blade optimization for aerodynamic performance and thermodynamic enhancements which could result in improved fuel consumption for Army vertical lift vehicles. Will also investigate injection technologies, micro nozzle and outward opening nozzles, that offer the potential to shorten liquid fuel penetration length and increase the rate of fuel injection at lower fuel pressures, to realize heavy-fuel operated small UAS and man portable generator engines. ***FY 2018 Plans:*** Will investigate and conduct experiments on engine and drivetrain technologies to enable improved performance and reduced maintenance costs for Army vehicles including (a) performance of a centrifugal compressor vaneless diffuser; (b) a variable area fuel injection nozzle concept for improved control of fuel quantity and jet penetration; (c) innovative active and passive articulating turbine rotor and stator blade mechanism concepts; (d) research in ceramic matrix composite (CMC) turbine blades;	3.117	2.678	1.538

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47B / *Veh Prop & Struct Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
(e) representation learning and model-assist diagnostic techniques for early damage detection in high-performance flight-critical powertrain gearing			
Title: Micro/Small Scale Unmanned Aerial Systems ***Description:*** Investigate platform, aerodynamic, actuation, transmission, and control technologies for handheld autonomous UAS. Handheld autonomous UAS will provide small units with significantly increased tactical mobility and deployability by extending soldier perception to real-time local Intelligence, Surveillance, and Reconnaissance (ISR) with handheld organic assets that help to minimize the supporting infrastructure needed for deployment. ***FY 2016 Accomplishments:*** Investigated a span-adaptive wing which yields relatively consistent performance across its span range while responding to slowly varying conditions in a wind tunnel; and validated with low degree-of-freedom surrogates, energy conservative behaviors inspired from biology. ***FY 2017 Plans:*** Will incorporate span adaptation in a closed-loop responding to sensory or operational inputs; assess measures of effectiveness for three-dimensional (3D) printed Unmanned Aeriel Vehicles (UAVs) validated by analysis under controlled conditions and develop and assess a tradespace analysis methodology to enable design of scaleable UAV platforms that takes into account different size platforms and specific missions. ***FY 2018 Plans:*** Will incorporate span adaptive wing structure into flight body, create appropriate flight behaviors, and assess resultant contribution to energy efficient yet agile flight. Will use experimentally collected data to validate and improve mission driven analytical UAV technology trade space tools. Will develop physics-based analytical tools for assessing performance impacts of multi-material technologies for UAVs.	1.717	3.488	4.073
Title: Aviation Component Failure Modeling ***Description:*** Develop failure analysis and prediction models and techniques to support a "zero maintenance helicopter" concept. Work is coordinated with Aviation component and system reliability efforts in PE 0602211A / Project 47A at the United States (U.S.) Army Aviation and Missile Research, Development and Engineering Center. ***FY 2016 Accomplishments:*** Developed the Virtual Risk-informed Agile Maneuver Sustainment (VRAMS) concept, which evaluates technologies to autonomously provide state awareness at the material level and automate stress-reduction methods; investigate a “virtual reality”	0.975	1.000	1.002

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47B / *Veh Prop & Struct Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
concept for self-diagnostics of real-time material state and automated solutions for self-directed maneuver alternatives in real-time. This effort will enables fatigue-free and zero-maintenance aircraft components. ***FY 2017 Plans:*** Will conduct nonlinear failure analysis; perform physics-based modeling; and determine analytical methods to utilize material damage precursors to assess remaining useful life for aviation structural components. ***FY 2018 Plans:*** Will develop a more efficient probabilistic and risk assessment method that can predict aviation component failure as damage is initially detected and continues to progress.			
Title: High Speed & Efficient Vertical Take-off and Landing ***Description:*** Perform Vertical Take-Off and Landing (VTOL) research investigations in propulsion, aeromechanics and platform technologies to explore, innovate and combine the most promising technologies to enable more efficient hover, high-speeds, and greater maneuverability at longer ranges for Army aviation. Reconfigurable and adaptive technologies include hover rotor systems that can achieve high speed, low drag; aerodynamic lift technologies capable of higher speed and efficient cruise; and convertible propulsion technologies to deliver more efficient hover and higher speed cruise power. ***FY 2018 Plans:*** Will investigate and develop active and passive technologies for structural damping augmentation to overcome structural performance limitations by developing physics-based mathematical models to enable higher fidelity analysis for concept assessment and capability projection. Will investigate engine cycle and powertrain configuration concepts that enable propulsors for efficient hover and high speed cruise.	-	-	1.503
Accomplishments/Planned Programs Subtotals	8.292	9.755	10.456

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602270A / *Electronic Warfare Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	18.502	25.466	27.144	-	27.144	26.575	26.513	26.954	27.372	-	-
906: *Tactical Electronic Warfare Applied Research*	-	18.502	25.466	27.144	-	27.144	26.575	26.513	26.954	27.372	-	-

A. Mission Description and Budget Item Justification

This Program Element (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.

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).

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 Army Research, Development and Engineering Command, Communications-Electronics Research, Development, and Engineering Center (CERDEC), Aberdeen Proving Ground, MD.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army					Date: May 2017
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*			R-1 Program Element (Number/Name) PE 0602270A / *Electronic Warfare Technology*		
B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	19.243	25.466	25.041	-	25.041
Current President's Budget	18.502	25.466	27.144	-	27.144
Total Adjustments	-0.741	0.000	2.103	-	2.103
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.741	-			
• Adjustments to Budget Years	0.000	0.000	2.000	-	2.000
• Civ Pay Adjustments	0.000	0.000	0.103	-	0.103

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602270A / *Electronic Warfare Technology*	Project (Number/Name) 906 / *Tactical Electronic Warfare Applied Research*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
906: *Tactical Electronic Warfare Applied Research*	-	18.502	25.466	27.144	-	27.144	26.575	26.513	26.954	27.372	-	-

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 fuzed 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.

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 in this Project is performed by the Army Research, Development, and Engineering Command, Communications-Electronics Research, Development, and Engineering Center (CERDEC), Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Multi-Intelligence Data Fusion and Targeting	2.615	2.720	2.780
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. Work being accomplished under Program Element (PE) 0603772A/Project 243 complements this effort.			
FY 2016 Accomplishments: Designed biometric/video architecture capable of pulling non-traditional biometric data from disparate video sources and integrate biometric extraction and analysis algorithms into this architecture; experimented with and evaluated software tools for biometric			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602270A / *Electronic Warfare Technology*	**Project (Number/Name)** 906 / *Tactical Electronic Warfare Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
extraction from video sources to determine ability to perform biometric extraction and pull useful intelligence, surveillance and reconnaissance data from the video using the biometric/video architecture. ***FY 2017 Plans:*** Will assess techniques for identifying necessary patterns and behaviors based on the types of data accessible from pertinent data sources accessed via the intelligence enterprise; design and code algorithms and software predictive analysis tools that support analysis of big data on the intel enterprise to determine patterns, anomalies, and behavior based upon data from various sources; evaluate the performance of tools against defined measures of effectiveness. ***FY 2018 Plans:*** Will mature predictive analyst tools to determine patterns, anomalies and behavior to correlate and exploit cyber big data sources; develop techniques and software tools to correlate dark web with clear web organizational personas; develop cyber threat indicators and ratios for identification of group patterns, tactics, techniques and procedures; and apply stylometry and authorship principles to cyber content to identify and group adversarial cyber themes.			
Title: Offensive Information Operations Technologies ***Description:*** This effort designs, codes and evaluates cyber architectures, software, tools and techniques that identify and capture data traversing targeted networks for the purpose of computer network operations (CNO) or otherwise countering adversary communications. Cyber capabilities include detection, identification, exploitation, direction finding (DF), geolocation, and denial of service. This effort leverages work being done under the Multi-function Intelligence, Surveillance and Reconnaissance (ISR) Technologies effort in this Project. Work being accomplished under PE 0603270A/Project K15 complements this effort. ***FY 2016 Accomplishments:*** Investigated advanced techniques against next-generation signals of interest (SOIs); researched an architecture for resilient operations across cyber, EW and signal intelligence (SIGINT) assets; investigated extending cyber enabled operations to software defined radio platforms such as dismounted/mounted radio and/or next generation radar systems. ***FY 2017 Plans:*** Will investigate additional advanced techniques to perform various SIGINT missions against identified SOIs; begin analysis of requirements for commander to perform command & control functions across security domains; analyze data to determine necessary data models for the delivery of tactically collected cyber electromagnetic activities (CEMA) data to the intelligence enterprise; investigate analytic tools to enhance commander's situational understanding by adding cyber data input; investigate next generation architecture requirements and research techniques to determine the current configuration state of the operational	5.618	7.857	7.984

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602270A / *Electronic Warfare Technology*	**Project (Number/Name)** 906 / *Tactical Electronic Warfare Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
offensive cyber operations architecture to enable automated replication within a laboratory environment; conduct experiments to validate necessary hardware and software component fidelity within the future architecture. ***FY 2018 Plans:*** Will validate advanced, software techniques to perform various cyber/EW functions against identified SOIs and devices of interest (DOIs); conclude requirements investigation and analysis of software architecture to allow the tactical commander to direct and control cyber functions from EW and SIGINT platforms across/within security domains and battlespace domain resources; incorporate the results of cyber laboratory experiments into the next generation architecture requirements and analysis of analytic tools that can inform the commander's situational understanding; and design and code the data models necessary for the delivery of CEMA data products to the intelligence enterprise.			
Title: Multispectral Threat Warning ***Description:*** This effort investigates and evaluates software and warning sensor/countermeasure components to increase probability of detection and defeat of 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 (HIL) simulations. ***FY 2016 Accomplishments:*** Investigated and developed hardware and software simulation environment to assess countermeasures with appropriate levels of simulation fidelity based on threat specifications and studies; explored ways to exploit a second class of emerging threats and assess baseline countermeasure techniques against this second class of emerging threat; developed holistic countermeasure approaches to protect aviation platforms and investigated application of additional technologies to support threat detection as well as optimization of countermeasure performance as part of the holistic approach. ***FY 2017 Plans:*** Will continue to perform threat characterization and countermeasure development for relevant threat targets; perform feasibility study on application of high energy lasers with improved laser technology and material development as countermeasures to existing and emerging threats; incorporate higher fidelity flare simulations into the simulation environment; collect and update data on advanced threats to update optical cross section database for use in simulation environment; incorporate threat characterization data into threat classifier software ***FY 2018 Plans:*** Will investigate threat agnostic warning algorithms to increase probability of detection of threats and provide identification and position information to the countermeasure system for an increased probability of defeat; based upon feasibility study results, investigate novel techniques using lasers of higher energy than currently used to increase the probability of defeat of threats not previously encountered; use M&S to develop new threat scenarios and mature HIL simulations that sense the electro-magnetic environment to assess existing countermeasure capabilities against previously unknown threats; investigate higher fidelity	5.104	5.367	6.605

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602270A / *Electronic Warfare Technology*	**Project (Number/Name)** 906 / *Tactical Electronic Warfare Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
countermeasures and incorporate them into the simulation environment; investigate threat agnostic countermeasure techniques against previously unknown threats and investigate the effects of combined EO/IR/RF technologies to defeat both multiple and multi-spectral threats.			
Title: Multi-Function Intelligence, Surveillance and Reconnaissance Technologies	4.011	8.522	8.771
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. Work being accomplished under PE 0603270A / Project K15 and PE 0603772A / Project 243, PE 0602709A/project H95 and PE 0603701A / Project K70 complement this effort. ***FY 2016 Accomplishments:*** Investigated and defined operational/technical requirements to design an open architecture RF front end for aerial and terrestrial platforms to allow multiple sensors access to platform antenna arrays to avoid redundancy; analyzed and determined specifications to standardize RF distribution networks on aerial and terrestrial platforms to facilitate modularity and the interoperability of RF systems. ***FY 2017 Plans:*** Will complete overall architecture design, module and processing specs and interfaces for the multi-function (defensive/offensive electronic attack, electronic support, SIGINT) RF front-end receiver; mature designs of the electronic modules including the low-band and mid-band input modules, pre-selector, N channel receiver, and master control/ computation/communications/ power modules; investigate and design the low band circular antenna array and mid band antenna array for terrestrial and aerial applications; begin reference design and development of processing engines for basic direction finding set-on and scan applications; investigate operational and technical requirements to develop high frequency (HF) exploitation software solutions. ***FY 2018 Plans:*** Will conduct experiments on reference design for multi-channel receiver architecture to assess baseline performance of commercial and Goverenment off the shelf (COTS/GOTS) receivers to determine optimal size, weight, and power and cost for a variety of EW and SIGINT missions, including direction finding and beamforming functions; continue to mature and validate Open RF Architecture interface specifications to support advanced interference mitigation between RF functionalities (e.g., communications, SIGINT and blue force jamming); mature interface specifications of intermediate processing functions to enable multi mission EW and SIGINT operations; standardize application interfaces across cyber, EW and SIGINT mission spaces to enable coordinated command and control (C2) of these capabilities to better address emerging threat signal classes; and begin investigation of Next Generation Radar architecture for compatibility with EW and SIGINT missions and architectures.			
Title: Electronic Warfare Architectures and Countermeasures	1.154	1.000	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602270A / *Electronic Warfare Technology*	**Project (Number/Name)** 906 / *Tactical Electronic Warfare Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Description: This effort investigates and evaluates the technical specifications of a family of threats to develop non-kinetic countermeasures. Work being accomplished under PE 0603270A/Project K16 complements this effort. ***FY 2016 Accomplishments:*** Analyzed modular open RF architecture interfaces to determine vulnerabilities that emerged as component interactions are standardized; continued the evaluation of emerging scheduling algorithms for use within the architecture to coordinate various mission functions (SIGINT, EW, Communications); designed software for automated classification, detection, identification and correlation algorithm to coordinate EW/SIGINT/Comms transmissions for real time communications across those mission functions. ***FY 2017 Plans:*** Will complete open RF architecture interface vulnerability analysis; develop and mature robust information assurance vulnerability mitigation techniques for the open RF architecture; begin analysis to apply the open RF architecture to RF capabilities on manned and unmanned airborne platforms; coordinate mitigation strategies and develop mitigation techniques for RF architecture vulnerabilities discovered for emerging SIGINT, EW, Communications scheduling algorithms.			
Title: Multi Function Electronic Warfare (MFEW) Technique Development ***Description:*** This effort investigates and develops EW techniques critical to countering communications, such as networked C2 nodes or improvised explosive device threats. 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 2018 Plans:*** Will investigate and perform vulnerability analysis on emerging commercial communications capabilities and investigate/develop EW techniques and methods (such as active, reactive, surgical and protocol based software) to defeat specific commercial communications systems while maximizing waveform jamming effectiveness, minimizing transmission time and reducing jamming power.	-	-	1.004
Accomplishments/Planned Programs Subtotals	18.502	25.466	27.144

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602270A / *Electronic Warfare Technology*	**Project (Number/Name)** 906 / *Tactical Electronic Warfare Applied Research*

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602303A / *Missile Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	51.801	44.313	43.742	-	43.742	46.919	47.742	50.936	51.695	-	-
214: *Missile Technology*	-	43.301	44.313	43.742	-	43.742	46.919	47.742	50.936	51.695	-	-
G05: *MISSILE TECHNOLOGY INITIATIVES (CA)*	-	8.500	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

This Program Element (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.

The 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, Robotics 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).

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.

The work in this PE is performed by the Aviation and Missile Research, Development, and Engineering Center (AMRDEC), Huntsville, AL.

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	53.553	44.313	45.326	-	45.326
Current President's Budget	51.801	44.313	43.742	-	43.742
Total Adjustments	-1.752	0.000	-1.584	-	-1.584
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.752	-			
• Adjustments to Budget Years	0.000	0.000	-1.712	-	-1.712
• Civ Pay Adjustments	0.000	0.000	0.128	-	0.128

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army	Date: May 2017
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602303A *I Missile Technology*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2016	FY 2017
Project: G05: *MISSILE TECHNOLOGY INITIATIVES (CA)*		
Congressional Add: *Program Increase*	8.500	-
Congressional Add Subtotals for Project: G05	8.500	-
Congressional Add Totals for all Projects	8.500	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602303A / *Missile Technology*	Project (Number/Name) 214 / *Missile Technology*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
214: *Missile Technology*	-	43.301	44.313	43.742	-	43.742	46.919	47.742	50.936	51.695	-	-

A. Mission Description and Budget Item Justification

This Project designs, fabricates, and evaluates missile and rocket component technologies that support demonstration of affordable, lightweight, highly lethal missiles and rockets. Major areas of research include: guidance, navigation, and controls; target acquisition systems; multi-spectral seekers; high-fidelity simulations; sustainment; aerodynamics and structures; launch systems, fire control technologies; payloads; and propulsion including research to help solve the insensitive munitions requirements. A theme embedded throughout the efforts in this project is smaller, lighter, and cheaper (SLC) missile technology to reduce the cost and logistical burden of precision munitions.

This Project supports the Army Science and Technology Lethality and Command, Control, Communications and Intelligence (C3I) portfolios.

Major products of this Project transition to PE 0603313A (Missile and Rocket Advanced Technology).

The cited work is consistent with the Director, Defense Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Work in this Project is performed by the Aviation and Missile Research, Development, and Engineering Center (AMRDEC), Huntsville, AL.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Missile Seeker Technology	3.612	4.659	4.740
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.			
FY 2016 Accomplishments: Fabricated, integrated, and tested novel micro-cooler technologies, improving size, weight, power and reliability of advanced infrared tactical seekers; designed and fabricated advanced ultra-small seeker components for integration into reduced-weight missiles, including aviation and long range fires missiles; developed and refined sensor and software algorithms to improve the detection and tracking of airborne threats			
FY 2017 Plans: Mature and assess capability of a compact, low cost radially omni-directional laser target detection device for the counter unmanned aerial systems (UAS) mission; mature and evaluate a laser-based, shared-aperture system capable of detecting and tracking sensor payloads of threat UAS; design a standard methodology and modeling capability to measure and track performance for passive sensors operating in the visible to infrared (IR) spectrum which will be applied to future tracker designs			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*	**Project (Number/Name)** 214 / *Missile Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
for improved and uniform performance; and design a strap-down, low-cost, IR seeker with passive precision acquisition and tracking algorithms for both stationary and moving targets; the seeker concept utilizes unique targeting solution with user-defined targets from reconnaissance imagery for true fire-and-forget engagements against a broad target set and is applicable in global positioning system (GPS) denied environments. Seeker hardware and interface are form factored for use on small guided munitions with modular open systems architectures. ***FY 2018 Plans:*** Will develop feature extraction/classification and tracker algorithms for resolved and unresolved unmanned aerial system to supplement existing surveillance assets; continue to develop infrared passive precision acquisition and tracking algorithms for true fire-and-forget engagements in GPS-denied environments with seeker hardware and interface formed for use on small guided munitions with modular open systems architectures; investigate technologies that support a low cost, strap down seeker system for counter unmanned aerial systems and will evaluate potential missile guidance errors; conduct design analysis for field of view, stabilization, resolution for a man-portable, Air Defense missile and investigate the performance of tactical optics over temperature with the use of additive manufacturing; develop a compact, low cost laser ranging sensor for range finding and target detection of personnel in defilade and develop a height of burst sensor for lethality against personnel.			
Title: Missile Guidance, Navigation and Controls Technologies ***Description:*** This effort designs, fabricates and evaluates guidance, navigation, and control systems and software, as well as information and signal processing systems for rocket and missile applications. Goals of this effort include more affordable missile guidance; miniaturization of guidance electronics; maintaining performance in 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. ***FY 2016 Accomplishments:*** Developed initial navigation, position, and timing testbed architecture to accept input from multiple sensors to include inertial, visual, and GPS to refine robust navigation fusion algorithms that provide accuracy in GPS assisted/degraded/denied environments; continuing development and evaluation of unique navigation technologies and algorithms aimed at reducing size, weight, power and cost, and dependence on the GPS while increasing or maintaining accuracy; designing novel technology for high current, extended life power sources, to enable longer flight times and increased shelf life of small guided missiles ***FY 2017 Plans:*** Continue to mature inertial navigation systems with efforts focused on miniaturizing high performance inertial system components into significantly smaller packages for tactical missile applications while maintaining affordability; design small, precision inertial sensors/accelerometers for fast, accurate north finding capability required to support target location systems/missile initialization; design novel battery technologies for high current batteries with high safety, low self-discharge, and long shelf life over wide range of temperature for long range small guided missiles; explore novel technology for augmentation of lithium polymer	6.188	7.630	7.773

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*	**Project (Number/Name)** 214 / *Missile Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
battery storage shelf life through integration of donor power storage technologies and subsystems to increase shelf life for small maneuvering missile applications; design a guidance and control algorithm that can leverage the computing capabilities available in emerging technology and characterize its ability to improve missile performance; design roll trajectories that significantly improves the inertial-only navigation performance of missile navigation systems using the existing roll control channel of the missile system, thereby improving system performance in GPS challenged environments; investigate current state-of-the-art additive manufacturing processes; design models and empirical data for multiple types of additive manufacturing materials and a materials database for applications to missile electronic systems; design processes to deposit electronic layers of radio frequency (RF) components in and within printed objects. ***FY 2018 Plans:*** Will refine and develop a multi-sensor survey system by integrating inertial navigation sensors, chip-scale atomic clock (CSAC), optics and Global Positioning System (GPS) to provide highly accurate Position, Navigation and Timing (PNT) data in GPS degraded or denied environments; refine the design of small, precision inertial sensors/accelerometers for fast, accurate north-finding required to support target location systems/missile initialization; continue design and fabrication of test articles for increased current capacity batteries for long range, small guided missiles; combine Radio Frequency (RF) and electronics in 3-dimensional (3D) printed objects, generate models and databases, and assess applications to reduce size, weight, and cost of missile systems; design microelectromechanical systems (MEMS) gyroscope and optical frequency shifting device for next generation inertial sensors; develop laser source filters for semi-active Laser seeker optics and develop advanced machine intelligence and image processing techniques for enhanced target acquisition and engagement; investigate magneto-electric composites, advanced system-on-a-chip (SoC) integrated circuit electronics parts, and design processes that reduce the amount of thermal buildup.			
Title: Missile Fire Control Systems, Sustainment, Simulations, and Launchers ***Description:*** This effort designs and evaluates fire control and tracking sensor technologies for area protection and air defense, technologies to increase missile useful life 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. Fire control radar effort is in coordination with PE 0602270A, Project 906 and PE 0603772A, Project 243. ***FY 2016 Accomplishments:*** Designed and fabricated critical phased array radar technology components for a novel radar testbed to support air defense activities such as threat identification and assessment and high-value asset protection; designed and fabricated radar testbed critical components such as transmit/receive modules; furthered mature target identification and classification algorithms focusing on integrating infrared imagery and development of ground target feature extraction increasing targeting fidelity and situational awareness; analyzed novel copper wire bond material properties and designed methodology to define qualification and	5.260	7.355	7.409

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*	**Project (Number/Name)** 214 / *Missile Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
acceptance for missile electronics reliability; developed initial RF predictive methodologies to create valid and reliable threat UAS RF models facilitating advanced simulations for air defense activities ***FY 2017 Plans:*** Continue digital radar testbed establishment to develop methods to counter evolving threats and maintain overmatch capability; continue with fabrication and evaluation of transmit/receive element array for increased firm track ranges and higher update rates; generate an Interface Control Document (ICD) between the digital radar testbed antenna array front-end and the Future Fires Radar open systems architecture back-end processing software to ensure compatibility and utilization for air defense capabilities; will continue to provide target identification algorithms for targets of interest with multiple sensor input; complete evaluation of reliability improvements of semiconductor devices using copper wire interconnects and identify key factors that mitigate negative reliability effects in target electronic devices; 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; continue to mature UAS modeling validation processes with establishment of RF predictive methodologies; establish methods to forecast the behavior and uncertainty of air defense targets to fully leverage independent shooter capabilities in a multiple shooter air defense context; design air defense shooter engagement management algorithms informed by target forecasting algorithms; and will design new modeling and simulation techniques to improve the fidelity of complex scene generation utilized in the evaluation and analysis of infrared sensors and seekers. ***FY 2018 Plans:*** Will further development of the Digital Array Radar Testbed (DART) which will be used in the development of methods to counter evolving threats and maintain overmatch capability; further fabrication and evaluation of transmit/receive element array for increased firm track ranges and higher update rates; refine the Interface Control Document (ICD) between the digital radar testbed antenna array front-end and the Future Fires Radar open systems architecture back-end processing software to ensure compatibility and utilization for air defense capabilities; investigate a radar employing a Low Probability of Intercept chaotic waveform to detect and track small UAS systems and document results to quantify system performance and investigate the transition of the technology to other Army Air Defense radars; will refine target identification algorithms for targets of interest with multiple sensor; further develop the design of modeling and simulation tools to enable increased weather fidelity with simultaneous results across all United States (US) and world climates; further develop UAS modeling validation processes with establishment of RF predictive methodologies; investigate designs for missile airframe stability and control that includes advanced materials and miniature actuator technology; establish behind armor debris prediction capabilities for multiple shaped charge materials and designs; investigate missile battery aging behavior and mechanisms responsible for degraded reliability; investigate the viability of an affordable common, man-portable fire control system to launch both ground and Air Defense missile. This effort will be conducted in conjunction with the Communications-Electronics Research, Development and Engineering Center (CERDEC) and Army Research Laboratory (ARL).			
Title: Missile Propulsion, Structures, Lethality, and Aerodynamic Technology	5.834	5.658	5.749

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*	**Project (Number/Name)** 214 / *Missile Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018

Description: This effort designs, fabricates, evaluates and tests missile enabling technologies including: advanced missile propulsion with reduced launch signatures; increased lethality and reduced weight and size using advanced materials and additive manufacturing. Missile Propulsion, Structures and Lethality efforts are in coordination with PE 0602618A, Project H80 and PE 0602624A, Project H28.

FY 2016 Accomplishments:
Continued test and refinement of novel propulsion systems to increase missile range and reduce time of flight for extended range propulsion systems; designed and conducted performance testing of structurally optimized missile components developed using additive manufacturing techniques for reduced weight and improved strength missile components; fabricated and performed system integration tests of lightweight warhead case technologies to provide reinforced structure defeat capability; investigated, scaled up and tested emerging disruptive energetic material from the ARL in coordination with the Armaments Research Development and Engineering Center (ARDEC); designed an experimental rocket motor intended to provide increased missile range via enhanced burning rate; created and evaluated novel aerodynamic structures to support extended range and maneuvering missile applications

FY 2017 Plans:
Continue to evaluate performance enhancement capability of physical burn rate augmentation for minimum signature propellant to improve volume efficiency of tactical missiles; utilize emerging energetic ingredient technologies to provide minimum smoke propellants that offer improved ballistic performance, improved mechanical properties over expanded temperature extremes, and enhanced safety performance under battlefield threats; design and characterize rocket nozzle and case insulation materials to improve insulation and erosive properties, and reduce cost for tactical missile applications; investigate and evaluate laser welding and light weight coating technology to reduce cost and manufacturing time for composite structures; design and validate logic/algorithms that integrate target classification and identification information available from multiple weapon platform sources; use target classification information to construct fuze commands for tailorable effects payloads that optimize target defeat, minimize collateral effects, and facilitate multi-use, tailorable effects weapons; and perform concept characterization and integration experimentation of brassboard designs of advanced shaped charge, explosively formed penetrators, and fragmentation technologies established in collaboration with ARDEC and ARL to enable a family of future munitions and missiles to enhance warfighter lethality and provide overmatch for the future battlefield.

FY 2018 Plans:
Will conduct static test firings in representative propellant grain geometries for both minimum smoke and high performance propellants; investigate attributes of technology to mitigate temperature sensitivity of reduced shock-sensitivity minimum smoke propellants; investigate low-cost integral rocket ramjet solutions, including combustion testing of advanced fuels, for Army missions to allow extended range within a smaller size than achievable using all-solid propulsion approaches; validate laser welding process and electrically conductive coating technology to reduce weight and cost of composite structures; design and

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*	**Project (Number/Name)** 214 / *Missile Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
test novel warhead technologies for providing overwhelming catastrophic effects against current and emerging threat vehicles to include Main Battle Tanks (MBT); refine concept characterization and integration experiments of brassboard designs of advanced shaped charge, explosively formed penetrators, and fragmentation technologies in collaboration with ARDEC and ARL to enhance warfighter lethality and provide overmatch; investigate approaches to reduce multi-spectral launch signature for minimum smoke propulsion systems; investigate the utility of a low-cost pulsed solid rocket motor approach to provide enhanced mission flexibility for aviation-launched small guided missiles; investigate modeling tools, additive manufacturing processes, and materials to optimize performance and reducing weight and cost of missile structures; investigate lethality performance low-cost reactive penetrators against dispersed targets.			
Title: Multi-Role Missile Technology	8.210	6.099	4.070
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. Successful technologies are matured and demonstrated in PE 0603313A, Project 263/704. ***FY 2016 Accomplishments:*** Refined detailed trade studies identifying critical technologies for next-generation close combat, precision missile systems enabling increased range for a man portable system; developed and evaluated 3D precision targeting software for Soldier, maneuver and fire support weapon applications; performed requirements definition, component trade studies, and preliminary component designs for a precision, maneuverable missile to meet emerging mission needs; designed and developed critical components (hardware and software) that support an open systems architecture to enable modular designs of guided and unguided missiles ***FY 2017 Plans:*** Evolve precision guided missile concepts based on emerging requirements; advance research and design missile technologies such as guidance and tracker algorithms; design novel hardware-in-the-loop (HWIL) capabilities through algorithm establishment and unique modeling and simulation test equipment required to support open system architecture concepts; continue to inform and evaluate detailed designs and identify critical components required; and integrate modular missile technology components and open system architecture into subsystems and verify subsystem performance in bench-level and laboratory environments. ***FY 2018 Plans:*** Will continue detailed designs and component development of low-cost guidance, navigation and control systems; multi-purpose warhead/fuzing technologies; and low-cost range finding and sighting systems for small unit precision lethality against multiple targets at extended ranges; design and conduct laboratory evaluations of subsystems for expanding the applicability of the modular open systems architecture to the drop/glide variant missile.			
Title: Air Defense Missile Technologies (formerly Counter Unmanned Aerial Systems and Counter Cruise Missile)	5.946	5.176	5.368

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*	**Project (Number/Name)** 214 / *Missile Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
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. This work supports efforts in PE 0603313A, Projects 263 & 704. ***FY 2016 Accomplishments:*** Continued development of critical interceptor technologies and components such as seeker, control system, mission computer, power system, and propulsion; designed and implemented software application algorithms for maneuver and fire support weapon targeting including expanded sensor inputs, threat flight path predictions, and calculated interceptor flight time for counter UAS missions ***FY 2017 Plans:*** Continue establishment, fabrication and evaluation of critical air defense interceptor technologies and components: control system, mission computer, and power system; and continue to design and implement software application algorithms for maneuver and fire support weapon targeting. ***FY 2018 Plans:*** Will further the design of critical air defense interceptor technologies and components; perform the mission computer, and power system laboratory bench testing and demonstration in preparation for integration into guidance electronics units for the Ballistic and Control Test Vehicle evaluations; continue design of the control actuation system and demonstrate it in laboratory dynamic flight test simulation apparatus; design and develop software algorithms to provide common targeting data across multiple tactical echelons, enabling a common operating picture for maneuver and fire support weapon targeting.			
Title: Affordable Precision Missile Enabling Technology ***Description:*** This effort focuses on the studies, design, establishment, fabrication, and evaluation of components and subsystems critical to produce affordable discriminate extended range precision missiles. Critical component technologies include: advanced propulsion, seekers/sensors, fire control, datalink, guidance, navigation and controls, and airframes. These technologies transition to PE 0603313A, Project 263 for maturation. ***FY 2016 Accomplishments:*** Conducted component/subsystem trade studies to determine subsystem requirements for an affordable discriminate extended range precision missile; began design of critical component technologies identified through subsystem trade studies ***FY 2017 Plans:*** Continue component/subsystem trade studies and refine and assess initial designs of critical component technologies to support the design of affordable discriminate extended range precision missile concepts. Critical component technologies include:	1.922	3.610	3.787

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*	**Project (Number/Name)** 214 / *Missile Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
advanced propulsion, seekers/sensors, fire control, datalink, guidance, navigation and controls, and maneuverable airframes, and platform integration. ***FY 2018 Plans:*** Will refine component/subsystem trade studies and begin to design, fabricate and test component technologies to provide the capability to engage maritime targets with lethal effects. Critical component technologies will include: sensors, data-links, guidance, navigation, controls, aerodynamics, thermal protection systems and fuze integrated payloads.			
Title: Long Range Fires Enabling Technology ***Description:*** This effort focuses on performing the necessary trade studies, and designing, establishing, fabricating and evaluating critical component technologies needed to support a long range fires capability. These technologies transition to PE 0603313A Project 263 for maturation. ***FY 2016 Accomplishments:*** Designed and began fabricating of advanced solid rocket motors to increase range for long range fires missiles; explored novel navigation techniques specific to the timelines required for long range fires missiles in GPS denied environments; integrated and conducted dynamic tests of a blast/fragmentation warhead and hardened multi-point fuze designed to produce effectiveness against both point and area targets, providing a single warhead variant for long range fires applications; conducted full scale tests against select military operations and urban terrain targets to characterize lethality ***FY 2017 Plans:*** Continue to investigate and assess emerging navigation technologies and techniques; design navigation system integration architectures and algorithms capable of integrating emerging navigation technologies into an alternate precision navigation solution; and continue performance evaluations of blast/fragmentation warhead and hardened multi-point fuze designed to produce effectiveness against both point and area targets. ***FY 2018 Plans:*** Will investigate emerging navigation technologies and techniques; design navigation system integration architectures and algorithms capable of combining emerging navigation technologies into an alternate precision navigation solution; design propulsion systems to increase the range of the system; design light weight airframe structures to increase range of the system.	6.329	4.126	4.846
Accomplishments/Planned Programs Subtotals	43.301	44.313	43.742

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*	**Project (Number/Name)** 214 / *Missile Technology*

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602303A / *Missile Technology*	Project (Number/Name) G05 / *MISSILE TECHNOLOGY INITIATIVES (CA)*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
G05: *MISSILE TECHNOLOGY INITIATIVES (CA)*	-	8.500	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

This is a Congressional Interest Item.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017
Congressional Add: Program Increase	8.500	-
FY 2016 Accomplishments: Program increase for missile technology research		
Congressional Adds Subtotals	8.500	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602307A / *Advanced Weapons Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	36.906	28.803	22.785	-	22.785	29.502	24.457	26.190	26.780	-	-
042: *High Energy Laser Technology*	-	28.306	28.803	22.785	-	22.785	29.502	24.457	26.190	26.780	-	-
NA5: *Advanced Weapons Components (CA)*	-	8.600	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

This Program Element (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) Project EM8, PE 0603004A (Weapons and Munitions Advanced Technology) Project L96 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.

B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	38.028	28.803	22.774	-	22.774
Current President's Budget	36.906	28.803	22.785	-	22.785
Total Adjustments	-1.122	0.000	0.011	-	0.011
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.122	-			
• Civ Pay Adjustments	0.000	0.000	0.011	-	0.011

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army	Date: May 2017
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602307A *I Advanced Weapons Technology*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2016	FY 2017
Project: NA5: *Advanced Weapons Components (CA)*		
Congressional Add: *Directed energy/thermal management program increase*	8.600	-
Congressional Add Subtotals for Project: NA5	8.600	-
Congressional Add Totals for all Projects	8.600	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602307A / *Advanced Weapons Technology*	Project (Number/Name) 042 / *High Energy Laser Technology*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
042: *High Energy Laser Technology*	-	28.306	28.803	22.785	-	22.785	29.502	24.457	26.190	26.780	-	-

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.

Work is performed by USASMDC/ARSTRAT in Huntsville, AL, and the High Energy Laser Systems Test Facility (HELSTF) at White Sands Missile Range, NM.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Solid State Laser Effects	5.221	3.557	3.674
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.			
FY 2016 Accomplishments: Concluded SSLT lethality data collection effort on representative rocket, artillery and mortar (RAM) and basic unmanned aerial system (UAS) targets; conducted field performance validation, analyze results; developed plan and schedule, and procured targets for follow-on threats to include cruise missiles and advanced UAS threats; and analyzed data and provided results from validation of 1.06 micron laser propagation models.			
FY 2017 Plans: Will investigate and collect data on advanced aimpoints for RAM and UAS threats; develop models and methodologies for energy efficient kill mechanisms for targets such as RAM, UAS, Man-Portable Air Defense System (MANPADS), and Cruise Missiles;			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602307A / *Advanced Weapons Technology*	**Project (Number/Name)** 042 / *High Energy Laser Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
develop a database for advanced materials for UAS and Cruise Missile threats and validate the weapon effectiveness against current and emerging threats, material compositions and threat protection layering combinations. ***FY 2018 Plans:*** Assess laser countermeasure effectiveness to include hardened materials, optical countermeasures, and tactics. Begin assessment of advanced threats to include: Anti-Tank Guided Missiles, Radar Systems, Rocket-Propelled Grenades (RPGs), and ground vehicles.			
Title: Advanced Beam Control Component Development ***Description:*** This effort investigates technologies to enable lighter, more agile beam control systems that are robust enough to be used in Army platforms. This work is done in collaboration with the HEL JTO and other Services. ***FY 2016 Accomplishments:*** Validated performance of an advanced, tactical, light-weight beam director during representative tactical laser engagements; validated advanced tracking concepts and atmospheric beam compensation at the SSLT in representative tactical laser engagements; continued development of All-Weather Tracker technologies, to include algorithms and component hardware; completed analysis and subscale experiments using segmented mirrors to validate improved ability to correct wavefront errors in a HEL; developed breadboard All-Weather Tracker that integrates algorithms and the sensor sub-system that will be compatible with the HEL mobile demonstrator (MD); developed data fusion algorithms and high frame rate image processing hardware and software; and developed adverse weather testing methods and equipment. ***FY 2017 Plans:*** Will conduct research on advanced methods of mitigating the effects of fog, rain, and dust on acquisition and tracking functions of an Army HEL system; further mature key sensor and track algorithm components of the enhanced tracking sensor for a high energy laser system; investigate integration of advanced sensors and components to improve acquisition and tracking at extended ranges; begin development of an advanced beam control system for demonstration on an Army platform. ***FY 2018 Plans:*** Complete the risk-reduction effort on adaptive optics performance in degraded atmospheric conditions. Validate performance requirements and the initial design of the beam control system (BCS) for the Preliminary Design Review for the next generation High Energy Laser system for an Army platform. This BCS will support an integrated demonstration of a laser weapon system prototype for potential transition into a Program of Record. This applied research on BCS components is part of the HEL technology demonstration.	3.158	3.781	7.342
Title: High Efficiency Laser Development	18.372	20.015	10.294

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602307A / *Advanced Weapons Technology*	**Project (Number/Name)** 042 / *High Energy Laser Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Description: This effort develops component technologies that increase SSL efficiencies, which will lead to reductions in size and weight for multiple subsystems that greatly improve the ability to integrate SSL systems into Army weapon platforms. This work is done in collaboration with the HEL JTO and other Services. Selected laser design will be fabricated and integrated onto an Army platform to demonstrate a high energy laser system functionality and is fully coordinated with PE 0603004A, Project L96. ***FY 2016 Accomplishments:*** Completed laser subcomponent fabrication and integration; completed fabrication of 28 double density high power fiber laser modules (>2kW each); demonstrated maintenance concept plan in the laboratory with the laser line replaceable units; completed the laboratory performance validation of the rugged, high efficiency laser to at least the ~50kW power level; began preparation of laser for integration, developed detailed integration plan for laser subsystem integration into an Army platform, and completed all the interface specifications; validated performance of a laser system integrated refrigerant cooling subsystem; and completed assessment of efficient laser power scaling to >100kW. ***FY 2017 Plans:*** Will complete populating a laser with mature fiber laser modules, bringing the system to the 50 kW-class performance level; conduct laser system performance verification and transition laser to PE 0603004A, Project L96 for further development and integration. Upon transition of the laser, assist (as the original equipment manufacturer) with the integration of the laser into the Army platform; improve the power density of the laser subsystem to allow scaling up to and potentially beyond 100 kW power output; investigate and develop fiber laser component technology to reduce system component size and weight for alternative platform applications. ***FY 2018 Plans:*** Complete the Preliminary Design Review of the next generation High Energy Laser system for an Army platform which includes validating performance requirements. Complete the majority of the work to hold the Critical Design Review of the laser system. This laser will provide the required power in the size and weight compatible with the selected Army platform for next pre-prototype system demonstration. The laser development is part of the HEL technology demonstration.			
Title: HEL Research and Development and Concepts Analysis Laboratories ***Description:*** This effort focuses on developing in-house expertise through 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. ***FY 2016 Accomplishments:*** Completed preliminary design and conducted experiments to verify Xenon laser design is scalable for potential next generation electric laser compactness, efficiency, and thermal management properties; began algorithm development and established an	1.555	1.450	1.475

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602307A / *Advanced Weapons Technology*	**Project (Number/Name)** 042 / *High Energy Laser Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
experimental testbed for non-beacon-based adaptive optics (AO) that could eliminate the need for the beacon illuminator as part of a HEL system, which would further reduce the size and weight of the system; characterized AO performance limits during horizontal beam propagation in a relevant environment; investigated radar enhancements to HEL MD fire control loop; refined models of space environmental effects on small satellites; and investigated small satellite propulsion and control designs for acquisition and tracking. ***FY 2017 Plans:*** Will conduct research into the development of a high efficiency, low Size, Weight and Power (SWaP) direct diode HEL as a next generation beyond the diode-pumped rare gas laser; investigate methods for AO systems to compensate for broader environmental effects, such as turbulence and low elevation battlespace. ***FY 2018 Plans:*** Complete investigation of candidates for suitability for Enhanced Tracking Sensor (ETS) to support the next generation BCS. This sensor will provide more capable acquisition and track of targets in degraded atmospheric conditions. Select candidate(s) and conduct laboratory level experiments to validate sensor performance satisfies requirements. Begin collecting field data to support model verification.			
Accomplishments/Planned Programs Subtotals	28.306	28.803	22.785

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602307A / *Advanced Weapons Technology*	Project (Number/Name) NA5 / *Advanced Weapons Components (CA)*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
NA5: *Advanced Weapons Components (CA)*	-	8.600	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

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 2016	FY 2017
Congressional Add: Directed energy/thermal management program increase	8.600	-
FY 2016 Accomplishments: Directed energy/thermal management program increase		
Congressional Adds Subtotals	8.600	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602308A *I Advanced Concepts and Simulation*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	26.886	27.688	28.650	-	28.650	35.100	35.494	36.177	36.892	-	-
C90: *Advanced Distributed Simulation*	-	20.335	20.589	23.223	-	23.223	28.577	28.841	29.392	29.968	-	-
D02: *Modeling & Simulation For Training And Design*	-	6.551	7.099	5.427	-	5.427	6.523	6.653	6.785	6.924	-	-

A. Mission Description and Budget Item Justification

This Program Element (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 (Clothing & Equipment Technology), PE 0602787A (Medical Technology), PE 0603001A (Future Warrior Technology Integration), 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 Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Work in this PE is performed by the Army Research Laboratory, Human Research and Engineering Directorate, Simulation and Training Technology Center (STTC), Orlando, FL.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army					Date: May 2017
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*			R-1 Program Element (Number/Name) PE 0602308A / *Advanced Concepts and Simulation*		
B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	27.862	27.688	28.631	-	28.631
Current President's Budget	26.886	27.688	28.650	-	28.650
Total Adjustments	-0.976	0.000	0.019	-	0.019
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.976	-			
• Adjustments to Budget Years	0.000	0.000	-0.004	-	-0.004
• Civ Pay Adjustments	0.000	0.000	0.023	-	0.023

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602308A / *Advanced Concepts and Simulation*	Project (Number/Name) C90 / *Advanced Distributed Simulation*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
C90: *Advanced Distributed Simulation*	-	20.335	20.589	23.223	-	23.223	28.577	28.841	29.392	29.968	-	-

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 Army Science and Technology Soldier/Squad portfolio.

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 Research Laboratory (ARL), Human Research and Engineering Directorate, Simulation and Training Technology Center (STTC), Orlando, FL.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Live, Virtual, Constructive (LVC) Simulations	7.807	6.975	-
Description: This effort develops and investigates LVC training technologies (tools and methods) to inform an interactive, seamless training environment. Live training refers to personnel and systems performing an exercise mission on real terrain; virtual training refers to personnel using simulators; and constructive training refers to computer based models representing real world behaviors that introduce a wider control of virtual forces. This effort is coordinated with and complements Program Element (PE) 0603015A/Project S29. In Fiscal Year (FY) 18 this effort has been refocused and renamed to Synthetic Natural Environments.			
FY 2016 Accomplishments: Investigated various component designs and developmental concepts of real world (physics-based) dynamic effects in terrain representation for use in the Army's One World Environment; researched, developed and assessed the use of the SCALE architecture in relevant use cases supporting the Army Learning Model (ALM); developed next generation simulation architectures and environments for the integration and execution of LVC simulations to be employed by joint and coalition warfare forces during collective training and mission rehearsal exercises; validated the effectiveness of select experimental tools and virtual environments on Soldier learning during joint and coalition training and mission rehearsal exercises; researched the effect of technologies such as interoperable performance assessment, mobile application use, data analytics, and social media on the			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*	**Project (Number/Name)** C90 / *Advanced Distributed Simulation*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
capability to conduct training and education on operational systems in support of United States Army Training and Doctrine Command (TRADOC) Army Learning Concept 2020-2040 goals; and developed a technique to measure, track, and manage general learning outcomes that will feed a continuous adaptive learning model. ***FY 2017 Plans:*** Will design and develop physics-based dynamic effect algorithms and synthetic terrain components to enable the Army's One World Environment for training; develop a cloud-based architecture to support adaptive training; develop prototype technologies, such as performance assessment, mobile application use, data analytics, and social media and assess impact on training and education for operational systems; validate methods to measure, track, and manage general learning outcomes that will feed a continuous adaptive learning model; and design and develop artificial intelligence algorithms to enable intelligent and believable behaviors of virtual characters that can be reused across virtual, constructive, virtual and gaming domains.			
Title: : Live and Medical Training Technologies ***Description:*** Included in this effort will be the development of new medical training simulations to train medical personnel across all levels of care and the development of live training technology that can be applied across all military levels and training environments. ***FY 2016 Accomplishments:*** Designed the laser component of the next generation Multiple Integrated Laser Engagement System (MILES) for a live training program of record at home stations and combat training centers supporting Force-on-Force training for Brigade Combat Teams (BCTs); applied measured tissue properties to experimental simulations and validated its performance; applied sensors to simulated tissue to objectively measure human performance and validate tissue performance; researched and developed immersive technologies to engage learners in game-based medical training. ***FY 2017 Plans:*** Will design and develop sensors and communication components to refine laser component design for next generation MILES capabilities; conduct research to characterize diseased and injured tissues to inform development of synthetic tissue; conduct research to simulate and model tissues in LVC platforms; investigate methods and technologies to assess human performance during training using high fidelity tissue/sensor solutions; and conduct research to assess human performance during medical training using various immersive hardware and software solutions. ***FY 2018 Plans:*** Will mature sensor and communication components of laser design for the next generation MILES in preparation to conduct experimentation. This research will improve the soldier’s live training performance for readiness at Army home station and Combat Training Centers. Will investigate accurate representation of simulation and training environments depicting the entire military	6.353	6.650	6.738

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*	**Project (Number/Name)** C90 / *Advanced Distributed Simulation*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
medical population to include, female, pediatric, and elderly, with simulated tissues that change over time based on injury, disease and healing, as well as improving anatomical accuracy by modeling representative patient data.			
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 2016 Accomplishments:*** Conducted initial user validation studies of usage of computer-based tutoring system (CBTS) authoring tools to supplement traditional classroom training with computer-guided tutoring per ALM; conducted research to expand intelligent tutoring system (ITS) domain models to represent Army training domains ; researched, developed, and evaluated instructional models for unit-level team tutoring. ***FY 2017 Plans:*** Will investigate the effectiveness of using realistic human driven avatars (puppeteering) in training applications on improving human performance; investigate effectiveness of current Army applied virtual distributed learning training; identify capability gaps in small team training as it relates to the Army's Synthetic Training Environment; develop automated authoring tools to supplement traditional classroom training with computer-guided tutoring per ALM; and mature intelligent tutoring system domain models to represent Army training domains; assess effectiveness of instructional models for unit-level team tutoring. ***FY 2018 Plans:*** Will conduct experiments to identify opportunities to enhance the capabilities of authoring tools and assess their effectiveness with the goal of reducing authoring times and allowing non-computer programmers the capability to generate sophisticated ITSs; will begin to mature and operationalize team tutoring concepts for the Synthetic Training Environments with respect to assessment and interaction between the team and the computer-based tutor.	5.015	5.764	5.495
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. This effort is coordinated with and complements PE 0602785/Project 790, PE 0602786/Project H98, PE 0602787/Project 869, PE 0603001/J50, and PE 0603710/ Project K70. ***FY 2016 Accomplishments:***	0.580	0.600	1.301

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*	**Project (Number/Name)** C90 / *Advanced Distributed Simulation*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Investigated the design of a simulation architecture that supports the development of a Soldier as a System simulation; investigated novel simulation solutions developed to link and synchronize models of human and system/equipment components; and developed metrics to analyze design tradeoffs between factors such as individual and team performance, system effectiveness, training requirements and cost. ***FY 2017 Plans:*** Will develop simulation components that link and synchronize models of human and system/equipment components to enable analysis within Soldier Systems Engineering Architecture; and investigate modeling & simulation framework limitations and propose remediation activities to enable cross-community/domain/user accessibility and re-use of modeling and simulation architectures. ***FY 2018 Plans:*** Will develop and mature enhanced simulation representations leveraging emerging Soldier Resilience and Effects of Stress on Shooter Performance study data supporting Soldier Systems Engineering Architecture (SSEA) use case analysis; will conduct experiments using developed simulation components in a relevant SSEA operational scenario; and will develop additional modeling and simulation (M&S) tools/technologies and Systems Engineering Processes as recommended in the SSEA (MS&T) Implementation Plan.			
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 legacy systems that require training of primarily procedural tasks. This is compounded by parallel increases in autonomy and responsibility at lower echelons. This effort is coordinated with and complements PE 0603015A/Project S29 and 0602716A/ Project H70. ***FY 2016 Accomplishments:*** Research, develop and evaluate models, methods and tools to identify best practices for training with autonomous systems/ technology to assess the effectiveness of various training strategies consistent with Army doctrine. ***FY 2017 Plans:*** Will conduct experiments to assess effectiveness of best practice training strategies for autonomous systems. ***FY 2018 Plans:***	0.580	0.600	1.301

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*	**Project (Number/Name)** C90 / *Advanced Distributed Simulation*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will mature concepts to optimize training strategies for autonomous systems; and develop recommender system to reinforce experiential learning of autonomous systems via machine learning techniques.			
Title: Rapid Soldier Capability Enhancement - Training ***Description:*** Research the relationship of augmentation agents and Soldier performance & behavior. Investigate the effects of augmentation agents (perceptual, cognitive, and/or physical), used either individually or coupled as a system of agents, on Soldier performance, resilience, and training during operationally relevant tasks. Development of guidelines and models for designing and employing augmentation agents. Implementation of guidelines will enhance augmented Soldier performance. This research is coordinated with PE 0602716A/Project H70. ***FY 2018 Plans:*** Will investigate augmentation application, including timing, amplitude, and duration relative to biological and environmental signals, to understand functionality in varied and complex environments. Model performance and adaptation to augmentation agents in order to predict capability enhancement; investigate individual variability and short and long term adaptation to augmentation agents. Explore the extension of methods and metrics developed for single augmentation agent to the quantification of Soldier performance while using a system of augmentation agents.	-	-	2.184
Title: Synthetic Natural Environments ***Description:*** This effort investigates and develops tools and methods to improve the speed, fidelity and delivery of synthetic terrain and environmental data to support Training Aid Devices (TADs), simulation and mission rehearsal systems. This effort is coordinated with and complements PE 0603015A/Project S28. ***FY 2018 Plans:*** Will investigate physics-based dynamic algorithms and terrain components in a cloud based computing environment for the Army's One World Terrain representation. This research will provide environment representation in order to deliver training in mission rehearsal for soldiers at the point of need.	-	-	6.204
Accomplishments/Planned Programs Subtotals	20.335	20.589	23.223

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*	**Project (Number/Name)** C90 / *Advanced Distributed Simulation*

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602308A / *Advanced Concepts and Simulation*	Project (Number/Name) D02 / *Modeling & Simulation For Training And Design*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
D02: *Modeling & Simulation For Training And Design*	-	6.551	7.099	5.427	-	5.427	6.523	6.653	6.785	6.924	-	-

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 Army Science and Technology Soldier/Squad portfolio.

Developed technologies and techniques are transitioned for maturation and demonstration to Program Element (PE) 0603015A/Project S28 (Immersive Learning Environments).

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 Research Laboratory, Human Research and Engineering Directorate, Simulation and Training Technology Center (STTC), Orlando, FL.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Immersive Technology Environments	3.276	3.550	2.714
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.			
FY 2016 Accomplishments: Investigated the effect on trainee learning and emersion experience within a virtual environment when low-cost scanning sensors and data capture techniques are used to rapidly capture and insert avatars representing the appearance and behaviors of actual trainees; experimented with adding mobile communication devices to the virtual human architecture to examine long-term			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*	**Project (Number/Name)** D02 / *Modeling & Simulation For Training And Design*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
interactions with virtual coaches and mentors; and determined the effectiveness of using virtual humans for interviewing patients in support of assessing Post Traumatic Stress Disorder. ***FY 2017 Plans:*** Will investigate the use of reinforcement learning to adapt, modify and improve engagement strategies for virtual learning environments; improve and extend capabilities of online virtual support agents so that they can respond appropriately even when user inputs are only partially understood and can be used via mobile phone applications; and develop tools for simulated crowd generation. ***FY 2018 Plans:*** Will develop technologies that enable the study of learning and engagement on mobile devices (e.g., smartphones) which are a key platform for future learning technology; develop cloud-based toolkit for recording, analyzing, and adapting to learner engagement and other emotions for both web-based and mobile platforms; and develop tools and processes to ease the authoring and deployment of conversational virtual coaches across multiple computing platforms to include import/export, integration, and debugging features.			
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 2016 Accomplishments:*** Conducted research to develop learner models for adaptive training environments focusing on strategies to increase learner attention and engagement; and investigated natural language computer processing techniques to translate real-world narratives into authorable interactive narratives for immersive environments.. ***FY 2017 Plans:*** Will advance research on autonomous agents for capturing training performance of users in indoor environments, and investigate the capture of three-dimensional (3D) geometry from the robotic platform; investigate how real-world data can be acquired and incorporated into simulated environments to increase the degree of user immersion; investigate the use of reinforcement learning to adapt, modify and improve engagement strategies for virtual learning environments; and develop authoring tools to allow virtual humans to be created and maintained by collaborators and other external sources. ***FY 2018 Plans:***	3.275	3.549	2.713

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*	**Project (Number/Name)** D02 / *Modeling & Simulation For Training And Design*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will conduct empirical studies to better understand perceptual mechanisms and design parameters that are important for multi-user virtual reality environments; and develop, integrate, and demonstrate enhanced automated language computer processing techniques for translating real-world narratives into authorable interactive narratives for immersive simulations.			
Accomplishments/Planned Programs Subtotals	6.551	7.099	5.427

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602601A / *Combat Vehicle and Automotive Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	95.763	67.959	67.232	-	67.232	68.826	72.085	78.336	85.815	-	-
C05: *Armor Applied Research*	-	28.092	24.380	21.428	-	21.428	26.291	24.442	23.143	35.506	-	-
H77: *National Automotive Center*	-	15.125	15.936	17.977	-	17.977	12.094	12.423	14.929	15.288	-	-
H91: *Ground Vehicle Technology*	-	22.946	27.643	27.827	-	27.827	30.441	35.220	40.264	35.021	-	-
T26: *Ground Vehicle Technologies (CA)*	-	9.600	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-
T31: *NAT'L AUTO CENTER APP RES INIT (CA)*	-	20.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

This Program Element (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 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 the Modular Active Protection System (MAPS). Project H77 funds the National Automotive Center (NAC), 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 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.

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), 0603734 (Military Engineering Advanced Technology), and 0708045A (Manufacturing 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.

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.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army	Date: May 2017
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602601A *I Combat Vehicle and Automotive Technology*

Work in this PE is performed by the Tank Automotive Research, Development, and Engineering Center (TARDEC), Warren, MI.

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	98.439	67.959	65.912	-	65.912
Current President's Budget	95.763	67.959	67.232	-	67.232
Total Adjustments	-2.676	0.000	1.320	-	1.320
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.004	-			
• SBIR/STTR Transfer	-2.672	-			
• Adjustments to Budget Years	0.000	0.000	1.109	-	1.109
• Civ Pay Adjustments	0.000	0.000	0.211	-	0.211

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2016	FY 2017
Project: T26: *Ground Vehicle Technologies (CA)*		
Congressional Add: *Program Increase*	9.600	-
Congressional Add Subtotals for Project: T26	9.600	-
Project: T31: *NAT'L AUTO CENTER APP RES INIT (CA)*		
Congressional Add: *Alternative Energy Research*	20.000	-
Congressional Add Subtotals for Project: T31	20.000	-
Congressional Add Totals for all Projects	29.600	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / *Combat Vehicle and Automotive Technology*	Project (Number/Name) C05 / *Armor Applied Research*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
C05: *Armor Applied Research*	-	28.092	24.380	21.428	-	21.428	26.291	24.442	23.143	35.506	-	-

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 Program Element (PE) 0603005A, Project 221.

This Project supports Army science and technology efforts in the Ground Maneuver portfolio.

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 in this Project is performed by the Tank Automotive Research, Development, and Engineering Center (TARDEC) Warren, MI and is fully coordinated with work at the Army Research Laboratory (ARL), Aberdeen Proving Ground, MD and at Communications-Electronics Research, Development and Engineering Center (CERDEC), Aberdeen Proving Ground, MD and Fort Belvoir, VA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Advanced Armor Development:	12.448	9.893	11.025
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. This effort coordinates with PEs 0602618A and 0603005A.			
FY 2016 Accomplishments: Developed new armor materials and mechanisms to achieve an overall ground vehicle armor subsystem weight reduction of 10-15%. Matured advanced passive and explosive reactive armor component technologies using new and novel material selections and design approaches for defeat of kinetic energy threats, chemical energy threats, and improvised explosive devices. Conducted advanced passive kinetic energy armor and explosive reactive armor integration experiments for component integration, and system seams and attachments. Began validation of advanced passive B-Kits, and advanced reactive armor			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** C05 / *Armor Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
systems for C-Kits by conducting ballistic experiments. Matured lightweight materials for structural application and structural designs to provide the protection capability required when integrated with B-Kit and C-Kit armor. ***FY 2017 Plans:*** Will complete advanced passive B-Kit and C-Kit integration experiments for component integration, and system seams and attachments; will use the integration experiment results to identify and design the desired seam and attachment approach for follow-on integration and demonstration of those technologies; will complete validation of the ballistic performance of the B-kit and C-kit technologies through ballistic coupon experiments; will conduct modeling and simulation of the next generation armor systems that evaluate integration feasibility and resulting performance of those technologies. ***FY 2018 Plans:*** Will mature attachment designs for subsystem integration of advanced passive and reactive armor technologies; verify performance of subsystem integration design for advanced passive and reactive armor technologies through finite element modeling; will investigate various adaptive armor solutions in relevant environment; will begin design of adaptive armor subsystem for system integration.			
Title: Blast Mitigation: ***Description:*** This effort designs, fabricates and evaluates advanced survivability and protection capabilities, tools and technologies to improve protection against vehicle mines, improvised explosive devices (IEDs) and other underbody threats and crash events. This effort also designs and evaluates technologies purposed for protecting the occupant such as seats and restraints. Blast and crash mitigation technologies are further investigated and matured in such areas as active and passive 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. This effort coordinates with PEs 0602618A and 0603005A. ***FY 2016 Accomplishments:*** Developed blast mitigation technologies to include seats, restraints, flooring and structures at the component and sub-system level to verify sub-system interactions. Evaluated passive and active technology solutions using Finite Element Modeling and Simulation tools along with sub-system laboratory tools to develop a variety of concepts. Verified component and sub-system design guidelines and evaluation techniques. Matured the Warrior Injury Assessment Manikin (WIAMan) in the laboratory environment through durability, repeatability and sensitivity tests of the WIAMan device components and system. Began development of WIAMan test device certification procedures through calibration testing. ***FY 2017 Plans:*** Will complete the design of subsystem concepts for the integration of seats, restraints, flooring and structures; will verify subsystem concepts and the associated technology interactions of the seats, restraints, flooring and structures through	6.384	3.335	2.932

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** C05 / *Armor Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
performance modeling and simulation; will develop certification test procedures to enable verification of the next generation WIAMan technology demonstrator based on laboratory and calibration testing. ***FY 2018 Plans:*** Will design subsystem concepts for integration of armor and Modular Active Protection System (MAPS) surrogate hardware; will validate design of subsystem components required for integration of seats, restraints, flooring and structures through structural and blast analysis; will mature WIAMan certification test procedures based on test results.			
Title: Synergistic Vehicle Protection Technologies: ***Description:*** This effort investigates and integrates advanced synergistic survivability technologies and simulation tools to provide enhanced protection for ground vehicles while minimizing overall system burdens. Synergistic survivability technologies such as, armor and active protection, offer the potential of non-linear survivability improvements. The modular approach facilitates trade-offs between protection, payload, performance, cost drivers and performance of vulnerability assessments throughout the life cycle of a system. Provides quantifiable metrics for development of requirements and evaluation of concept feasibility in the development of survivable combat systems. ***FY 2016 Accomplishments:*** Leveraged the enhanced protected mobility optimization and assessment tools and methodologies developed previously to design future vehicle concepts, optimized protection and mobility technologies to minimize system burdens, and identified future technology metrics and requirements. ***FY 2017 Plans:*** Will utilize survivability and mobility assessment tools and methodologies to continue to develop future vehicle concepts targeting a range of vehicle weight classes; will investigate vehicle concepts that are modular in nature to accommodate multiple mission requirements; will explore vehicle concepts that utilize lightweight non-structural components while maintaining survivability and mobility performance.	0.651	2.202	-
Title: Improved Situational Awareness for Ground Platforms ***Description:*** This effort investigates situational awareness (SA) technologies and architectures to improve occupant and vehicle survivability in all conditions and environments to include degraded visual environments (DVE) for ground vehicles. This effort also investigates and analyzes electronic architectures to enable the efficient integration of DVE systems such as intra-vehicle data and video networks, SA input/output devices, and associated software architectures and interfaces. This effort coordinates with PEs 0603005A, 0602709A, and 0603710A. ***FY 2016 Accomplishments:***	6.760	7.242	5.608

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** C05 / *Armor Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Integrated aviation-based DVE sensors onto an Indirect Vision Driving vehicle through the Integrated Digital Video System (IDVS); developed algorithms that determine how to take World Model information from various sources and overlaid that information in real time on the Indirect Vision Driving screens to aid the vehicle operator in visually occluded environments. Conducted human-in-the-loop experiments of the Indirect Vision Driving system augmented with DVE sensors. ***FY 2017 Plans:*** Will design and develop scalable sensing and immersive intelligence for local SA for DVE for ground vehicle systems; will develop digital architecture and sensor processing with in-vehicle displays for the indirect vision driver. Will investigate hostile fire localization and collision avoidance through the radar and electro-optic sensor, which will improve situational awareness, improve indirect driving maneuverability, and threat detection for improved vehicle and occupant survivability. ***FY 2018 Plans:*** Will validate increased SA in DVE to enable indirect vision driving maneuverability, driving aids to reduce accidents & threat detection to improve survivability. Will improve operational tempo (OPTEMPO) in DVE to maintain OPTEMPO and decrease occupant injury. Will optimize aviation capabilities provided by the Degraded Visual Environment Mitigation (DVE-M) program to provide a complete sensor that is scalable to the mission and vehicle family.			
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. Coordinated work is also being performed in PEs 0602120A, 0602705A, 0602712A and 0603005A. ***FY 2016 Accomplishments:*** Conducted damage threshold and damage mechanism studies on current day cameras and optical systems from short-pulsed laser threats. Improved capability to conduct experiments and validation of protection concepts against emerging laser threats. ***FY 2017 Plans:*** Will evaluate high energy laser threats to determine their threat parameters for testing sensors against the threats; will develop concepts to protect current systems against the ultra-short pulse laser threat that leverages initial capability testing completed on power-limiting materials. ***FY 2018 Plans:***	1.849	1.708	1.863

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** C05 / *Armor Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will conduct experiments to mature protected day cameras for near-term threat protection; design and mature concepts for future systems to protect against current and future laser threats; improve laboratory capability to enable integration and testing of vision protection concepts on ground vehicles.			
Accomplishments/Planned Programs Subtotals	28.092	24.380	21.428

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / *Combat Vehicle and Automotive Technology*	Project (Number/Name) H77 / *National Automotive Center*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
H77: *National Automotive Center*	-	15.125	15.936	17.977	-	17.977	12.094	12.423	14.929	15.288	-	-

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 Assistant 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 Tank Automotive Research, Development, and Engineering Center (TARDEC), Warren, Michigan.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Power, Energy and Mobility:	4.072	4.309	4.391
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. This work is done in conjunction with Program Elements (PEs) 0603005A and 0603125A.			
FY 2016 Accomplishments: Continued joint activities with Department of Energy and Department of Transportation to exploit fuel efficient vehicle operation for military platforms and duty cycles. Continued to support the transition of technology to/from industry and government. Developed and matured fuel cell systems for initial integration experiments of fuel cells onto vehicles. Investigated fuel reduction and water generation technologies to determine logistical impacts, leveraging commercial and academic investments.			
FY 2017 Plans: Will continue to support the transition of technology to/from industry and government. Will continue to investigate fuel reduction and water generation technologies to determine logistical impacts, leveraging commercial and academic investments. Will mature			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H77 / *National Automotive Center*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
fuel quality monitoring technologies for dual use in commercial, combat, and tactical systems. Will design and develop water treatment and reuse technologies to reduce logistics burdens of resupplying water to the battlefield. Will continue to collaborate with automotive industry and Department of Energy in fuel cell technology maturation. ***FY 2018 Plans:*** Will continue to investigate new computer-aided engineering tools for vehicle batteries that can accurately predict the combined structural, electrical, and thermal responses to military usage conditions. Will continue to investigate new computer-aided engineering tools for vehicle engines that accurately model fuel injection spray, cavitation within fuel injectors, flash boiling, spray/wall interaction, super critical fuel injection, in-cylinder radiation and heat transfer, engine knock and soot emissions. Will continue to investigate alternate integrated starter generator motors that achieve the required power and torque densities without Rare-Earth materials. Will continue to collaborate with automotive industry and Department of Energy in fuel cell technology maturation.			
Title: Dual Use Technologies: ***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. This work is done in conjunction with PE 0603005A. ***FY 2016 Accomplishments:*** Continued to leverage commercial automotive and trucking research and development centers to transition reliable, affordable technology solutions to our military ground vehicle fleet. Continued to leverage industry's state of the art vehicle electrification and open vehicle architecture standards and facilitate transition into military ground vehicles. Continued to research and develop autonomous vehicle standards with industry and other government organizations. Matured intelligent ground vehicle systems and develop mission payloads for dual use applications to increase efficiencies. Investigated solutions to transition commercial fuel cell technologies to military ground systems. ***FY 2017 Plans:*** Will continue to leverage commercial automotive and trucking research and development centers to transition reliable, affordable technology solutions to our military ground vehicle fleet. Will continue dual use collaborative investigations of military & commercial open vehicle architecture standards, electrification standards, vehicle security engineering best practices, and communication systems integration challenges through collaborative mechanisms such as High-efficiency Truck Users Forum	11.053	11.627	13.586

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H77 / *National Automotive Center*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
(HTUF). Will design and develop dual use autonomy-enabled vehicle component technologies and material handling equipment for use in reducing convoy manpower and optimizing logistical operations. ***FY 2018 Plans:*** Will continue to leverage commercial automotive and trucking research and development centers to transition reliable, affordable technology solutions to our military ground vehicle fleet. Will continue dual use collaborative investigations of military & commercial ongoing open vehicle architecture standards, electrification standards, autonomous systems technologies and integration, vehicle security engineering best practices, and communication systems integration challenges through collaborative mechanisms such as the Society of Automotive Engineers, Automation Alley, the Center for Automotive Research (CAR), and the HTUF. Will conduct integration of autonomy systems on international vehicles and demonstrate an autonomous convoy with advanced vehicle behaviors.			
Accomplishments/Planned Programs Subtotals	15.125	15.936	17.977

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / *Combat Vehicle and Automotive Technology*	Project (Number/Name) H91 / *Ground Vehicle Technology*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
H91: *Ground Vehicle Technology*	-	22.946	27.643	27.827	-	27.827	30.441	35.220	40.264	35.021	-	-

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, 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 Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Combat Vehicle Modernization Strategy.

Work in this Project is performed by the Tank Automotive Research, Development, and Engineering Center (TARDEC), Warren, Michigan. Efforts in this Project are closely coordinated with the Army Research Laboratory (ARL), the Defense Advanced Research Projects Agency (DARPA), the Army Engineer Research and Development Center, Edgewood Chemical Biological Center (ECBC), and the Army Medical Command (MEDCOM).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Pulse Power:	3.293	3.568	-
Description: This effort focuses on growing compact, high frequency/high energy/high power density components and devices for several advanced electric-based survivability and lethality weapon systems. Technologies include direct current (DC) to DC chargers, high energy batteries, pulse chargers, high density capacitors, and solid state switches. This effort is coordinated with Program Elements (PEs) 0603005A and 0602705A.			
FY 2016 Accomplishments: Completed the design and integration of energy storage and high-voltage power electronic components into a system that enables high mass-efficiency electromagnetic threat defeat mechanisms. Began pulse power system laboratory testing to validate the power system performance needed for electromagnetic armor threat defeat. Completed design of an electromagnetic armor module.			
FY 2017 Plans: Will complete laboratory testing of pulse power system performance to enable electromagnetic armor threat defeat. Will complete pulse power system environmental and durability laboratory testing to validate the ability of the system to operate in			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 / *Ground Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
relevant environments. Will mature electromagnetic armor modules in preparation for testing of the integrated pulse power and electromagnetic armor system.			
Title: Propulsion and Thermal Systems: ***Description:*** This effort researches, designs and evaluates high power density engines and transmission systems needed to offset increasing combat vehicle weights (armor), improved fuel economy (fuel cost & range), and reduced cooling system burden (size, heat rejection). This effort also researches and matures thermal management technologies and systems including heat energy recovery, propulsion and cabin thermal management sub-systems to utilize waste heat energy and meet objective power and mobility requirements on all ground vehicles. Lastly, this effort maximizes efficiencies within propulsion and thermal systems to reduce burden on the vehicle while providing the same or greater performance capability. This effort is coordinated with PE 0603005A. ***FY 2016 Accomplishments:*** Designed and developed an advanced heat exchanger and efficient fan subsystem to increase cooling capabilities and fuel efficiency. Designed waste heat recovery system for military vehicle applications to provide additional onboard electrical power. Matured engine component concept designs through thermal, structural and reliability modeling and simulation. ***FY 2017 Plans:*** Will investigate advanced heat exchanger and efficient fan components to determine cooling performance and component efficiencies. Will conduct analysis and cooling system design optimization on an advanced combat vehicle propulsion system design that incorporates the advanced cooling components with a waste heat recovery system that maximizes propulsion cooling performance and minimizes parasitic power draw from the vehicle. ***FY 2018 Plans:*** Will mature advanced heat exchanger, efficient fan, and waste heat recovery system into advanced thermal management system. Will mature advanced thermal management system concept design in preparation of integration into advanced combat vehicle propulsion system.	4.928	5.895	6.466
Title: Power Management Technologies: ***Description:*** This effort investigates power management technologies, software, and implementation approaches. Technologies include Alternating Current (AC) to Direct Current (DC) inverters, DC-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. This effort coordinates with PE 0603005A. ***FY 2016 Accomplishments:***	2.484	2.625	2.685

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 / *Ground Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Completed development of the next generation power architecture and corresponding system design using SiC power electronics and low cost computers. Integrated high and low voltage power components into a System Integration Lab (SIL) and conduct validation of the power architecture and power electronics in the SIL, demonstrating SiC and automated power management. ***FY 2017 Plans:*** Will conduct analysis and system integration laboratory testing power architectures for the next generation military vehicles in order to provide efficient distribution and control of power across the platform. Will begin power architecture control software development in order to establish power quality, prioritization and optimization algorithms that maximize available power on the vehicle. Will begin environmental, electromagnetic interference (EMI) and reliability performance testing of vehicle power architecture system components. ***FY 2018 Plans:*** Will complete testing of Gallium Nitride (GaN) and SiC based leap-ahead electrical power system in the SIL to troubleshoot issues in preparation for future combat vehicle integration. Will continue environmental, EMI, reliability performance, and other testing of vehicle power architecture system components and software to prepare for future combat vehicle testing.			
Title: Power Electronics, Hybrid Electric and Onboard Vehicle Power (OBVP) Components:	1.172	1.288	0.750
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. This effort is coordinated with PE 0603005A. ***FY 2016 Accomplishments:*** Designed and developed a high power generator, high temperature inverter and electronic controls strategy to electrify and control parasitic vehicle automotive loads to increase onboard vehicle power availability and fuel efficiency with no negative impact to vehicle mobility. ***FY 2017 Plans:*** Will continue development of components for a high power generator, high temperature inverter and electronic controls strategy to electrify and control parasitic vehicle automotive loads to increase onboard vehicle power availability and fuel efficiency with no			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 / *Ground Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
negative impact to vehicle mobility. Components will be assembled into a brass board configuration to begin system design and control algorithm development for a vehicle power system control strategy. ***FY 2018 Plans:*** Will complete testing of integrated starter generator system in brass board configuration. Will begin analysis and system design optimization on an advanced combat vehicle propulsion system.			
Title: Advanced Non-Primary Power Systems: ***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. ***FY 2016 Accomplishments:*** Designed and developed high power rotary engine technologies to increase the power density up to two times current power densities of other heavy fueled internal combustion engines. Investigated and designed active noise control, muffler and insulation technologies to reduce the acoustic signature of engine-based APU to decrease detection during mounted surveillance missions. ***FY 2017 Plans:*** Will complete system analysis of an advanced APU to include cooling, dust mitigation and control approaches for a rotary engine-based engine-generator. Will continue the development of an approach to advanced noise control strategies that include technologies such as active noise cancellation, isolation and muffling to reduce acoustic signature of engine-based APUs to decrease auditory detection during mounted surveillance missions. ***FY 2018 Plans:*** Will investigate advanced APU to verify performance, control strategy and advanced noise control. Will continue to optimize active noise cancellation, isolation and muffling to decrease auditory detection during mounted surveillance missions.	1.838	1.298	1.327
Title: Elastomer Improvement Program: ***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. ***FY 2016 Accomplishments:***	0.637	0.662	0.662

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 / *Ground Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Fabricated elastomer samples with optimized compounds for durability evaluation. Validated durability evaluation data with predictive fatigue models. Performed design iterations of track system elastomer components based on field test results and fatigue modeling and simulation. ***FY 2017 Plans:*** Based on results from previous field testing, will update current compounds or designs for elastomeric components in both road wheels and track systems to improve durability performance. Will update modeling and simulation of elastomer durability models with validated results. Will fabricate the updated component designs for road wheels and track systems, and evaluate the latest designs through laboratory testing. ***FY 2018 Plans:*** Will formulate final compounds for selection and inclusion on the advanced running gear demonstration platform. Will mold compounds for the track pad, bushing and road wheels. Will perform final laboratory evaluations on selected finished product compounds and then produce quantity for demonstrator evaluations.			
Title: Intelligent Systems Technology Research: ***Description:*** This effort investigates improved operations of manned platforms through the application of sensing and autonomy technologies developed for unmanned systems such as maneuver and tactical behavior algorithms, driver assist techniques, autonomy kits, advanced navigation and planning, vehicle self-protection, local situational awareness, advanced perception, vehicle and pedestrian safety, active safety, and robotic command and control. This effort is coordinated with efforts in PEs 0602120A, 0602784A, 0603005A, and 0603734A. ***FY 2016 Accomplishments:*** Developed autonomous behaviors for mounted and dismounted ground vehicle systems that are adaptable to different missions and environments. Developed advanced cognitive control through feedback coupling of Soldier-Unmanned Ground Vehicle system capabilities and behavior at neural, neurocognitive, and sociocognitive levels. Matured reliable and consistent autonomous capabilities for mounted and dismounted ground vehicle systems to increase autonomous vehicle control and reduce required level of human interaction. ***FY 2017 Plans:*** Will investigate effective control of unmanned systems operating with soldier trust in autonomous systems, and manned/unmanned teaming. Will design and develop common interfaces, drive-by-wire, and advanced vehicle behavior technologies with immediate installation and base operation requirements that will allow investigation between controlled to uncontrolled hostile environments. Will design and develop the Warfighter-Machine Interface with scalability and driver/crew aids. Will investigate	6.363	9.832	9.917

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 / *Ground Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
tactical resupply perception models, location fidelity of supply, and software algorithms to meet dynamic stockage objectives to improve throughput. ***FY 2018 Plans:*** Will continue to design and develop the Warfighter Machine Interface for scalability and driver/crew aids. Will mature the increased reliability of robotic technologies to produce trust and confidence of autonomous vehicles. Will improve standardized data collection tools and methodologies to mature Department of Defense (DoD) ground robotic requirements, development, technology investments and procurement decisions. Will conduct experiments to validate that these tools and technologies are increasing our capabilities of protecting the force, reducing burden on soldiers, and mission command & tactical intelligence.			
Title: Energy Storage: ***Description:*** This effort investigates novel advanced ground vehicle energy storage devices such as advanced chemistry batteries and ultra capacitors for starting, lighting, and ignition and silent watch requirements for powering vehicle electronics and communications systems with main engine off. Develop and test energy storage devices to meet harsh military requirements that far exceed commercial requirements such as extreme temperature operation (-46 to +71C), ballistic shock and vibration, and electromagnetic interference (in accordance with MIL-STD-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. ***FY 2016 Accomplishments:*** Designed and developed advanced cell level materials to fit into standardized military battery form factors such as 6T. Designed improved advanced standardized battery prototypes by incorporating advanced cell materials. Developed and matured electrochemical cell designs to improve energy density, starting, lighting, propulsion system ignition, silent watch and reliability of military specific battery. ***FY 2017 Plans:*** Will conduct durability and performance testing at the battery cell level for advanced Li-ion chemistries to improve energy density, starting, lighting, propulsion system ignition, silent watch and reliability of military specific batteries. Will begin design work to package the battery cells into modules and full battery packs in the military form factor (6T), to include battery voltage monitoring, state of charge and battery safety control systems. ***FY 2018 Plans:*** Will design and mature battery cells into modules. Will then design and mature battery packs built around the modules. Will conduct durability and performance testing at the module level for advanced Li-ion chemistries.	2.231	2.475	2.520
Title: Anti-Tamper	-	-	3.500

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 / *Ground Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
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. ***FY 2018 Plans:*** Will develop measurement, analysis and verification methods to identify vulnerabilities of combat and tactical vehicle software-based technologies; will capitalize on currently available virtual (Modeling & Simulation) toolsets to design and 'virtually' conduct experiments of potential safeguards and solutions of the vehicle architecture, and will begin to evaluate methods and toolsets on ground vehicle hardware. Will investigate applications of anti-tamper that are applicable to both current and future vehicles.			
Accomplishments/Planned Programs Subtotals	22.946	27.643	27.827

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / *Combat Vehicle and Automotive Technology*	Project (Number/Name) T26 / *Ground Vehicle Technologies (CA)*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
T26: *Ground Vehicle Technologies (CA)*	-	9.600	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Ground Vehicle Technology applied research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017
Congressional Add: Program Increase	9.600	-
FY 2016 Accomplishments: This is a Congressional Interest Item.		
Congressional Adds Subtotals	9.600	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / *Combat Vehicle and Automotive Technology*	Project (Number/Name) T31 / *NAT'L AUTO CENTER APP RES INIT (CA)*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
T31: *NAT'L AUTO CENTER APP RES INIT (CA)*	-	20.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for National Automotive Center applied research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017
Congressional Add: Alternative Energy Research	20.000	-
FY 2016 Accomplishments: This is a Congressional Interest item.		
Congressional Adds Subtotals	20.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602618A / *Ballistics Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	118.221	85.436	85.309	-	85.309	86.797	88.861	89.956	93.699	-	-
H80: *Survivability And Lethality Technology*	-	93.221	85.436	85.309	-	85.309	86.797	88.861	89.956	93.699	-	-
HB1: *SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)*	-	25.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

This Program Element (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; and techniques, methodologies, and models to analyze combat effectiveness, and identify vulnerabilities of current and emerging technologies; and developing a demonstrator with associated 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 (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), 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 Advanced Technology), PE 0603313A (Missile and Rocket Advanced Technology), and PE 0708045A (Manufacturing Technology).

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 in this PE is performed by the Army Research Laboratory (ARL), Aberdeen Proving Ground, MD.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army					Date: May 2017
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*			R-1 Program Element (Number/Name) PE 0602618A / *Ballistics Technology*		
B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	117.801	85.436	89.905	-	89.905
Current President's Budget	118.221	85.436	85.309	-	85.309
Total Adjustments	0.420	0.000	-4.596	-	-4.596
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	3.000	-			
• SBIR/STTR Transfer	-2.580	-			
• Adjustments to Budget Years	0.000	0.000	-3.816	-	-3.816
• Civ Pay Adjustments	0.000	0.000	0.220	-	0.220
• Other Adjustments 2	0.000	0.000	-1.000	-	-1.000

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2016**	**FY 2017**
Project: HB1: *SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)*		
Congressional Add: *Program Increase*	20.000	-
Congressional Add: *Improved Armor Technologies*	5.000	-
Congressional Add Subtotals for Project: HB1	25.000	-
Congressional Add Totals for all Projects	25.000	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602618A / *Ballistics Technology*	Project (Number/Name) H80 / *Survivability And Lethality Technology*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
H80: *Survivability And Lethality Technology*	-	93.221	85.436	85.309	-	85.309	86.797	88.861	89.956	93.699	-	-

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); and techniques, methodologies and models to analyze combat effectiveness and identify vulnerabilities of current and emerging technologies; and developing a demonstrator and associated methods and analysis tools for injury prediction (due to underbody blast).

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

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 in this Project is performed by the Army Research Laboratory (ARL), Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Underbody Blast & Occupant Protection	5.165	2.220	1.598
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. This research is coordinated with Program Element (PE) 0602601A (Armor Applied Research) and PE 0603005A (Combat Vehicle Survivability).			
FY 2016 Accomplishments: Investigated structural damage and response due to buried blast and penetrator threats and proposed novel protection solutions to defeat these threats; designed active mechanisms including momentum transfer and other technologies to mitigate lower-extremity injuries.			
FY 2017 Plans: Investigate active and adaptive concepts, such as threat detection, to protect against buried blast and penetrator threats.			
FY 2018 Plans:			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will advance development of protection mechanisms to defeat penetrator mines; continue development of blast protection hull designs for ground platforms.			
Title: Low Cost Hyper-Accuracy Munition Technologies ***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 (GN&C) technologies. The goal is for smaller, cheaper and lighter munition components enabling low-collateral-damage precision munitions for future asymmetric operations in military operations on urban terrain (MOUT). ***FY 2016 Accomplishments:*** Developed nonlinear methods to assess flight dynamics and stability and to enhance control algorithm development for precision munitions; evaluated inertial navigation technologies to improve abilities to hit moving targets; and developed new electro-optic/ infrared-based navigation capabilities and assess associated in-lab maneuver performance of precision munitions. ***FY 2017 Plans:*** Advance development of nonlinear methods to assess aerodynamics and flight dynamics through coupled simulations, and apply to predict various geometry related flow interactions; and utilize various flight experiments to assess flight behavior of high maneuverability airframes and man-portable precision concepts such as use of video guidance to track and hit a moving target. ***FY 2018 Plans:*** Will conduct end-to-end launch and guided flight demonstration of moving target intercept on laboratory range with low cost components in moderate size, weight, and power package; will define critical technologies, scientific challenges, and engineering issues that inhibit precision weapons and future vehicle-mounted weapons against advanced threats.	3.706	3.758	3.779
Title: Disruptive Energetics and Propulsion Technologies ***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 (Ballistics) to synthesize new materials with energy content up to ten times that of Research Department Explosive (RDX). ***FY 2016 Accomplishments:*** Matured synthetic research on disruptive energetic materials, including nanodiamond-based materials and boron-based materials, confirming shock pressure/temperature enhancement and measuring energies delivered to target; designed laboratory experimental capabilities for evaluating gram-scale quantities of disruptive energetic materials to determine potential for further exploration and scale-up; explored methods to reduce power required to accelerate rounds for medium-caliber weapons	10.433	8.307	8.377

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
using computational fluid dynamics (CFD)-based models; and designed chemistry, thermodynamics, and multi-phase physics associated with increases in propellant burn rate sensitivity as a function of pressure to improve propellant efficiency and performance. ***FY 2017 Plans:*** Expand synthetic research for multiple classes of disruptive energetic materials; develop multiscale models to understand and predict chemical reactions, thermomechanical processes, and chemical compatibility of disruptive energetic materials; develop experimental and computational methods to improve understanding of initiation mechanisms; and use CFD-based models to explore methods to reduce power requirements in medium caliber weapons and begin extension to larger caliber systems. ***FY 2018 Plans:*** Will characterize performance of materials produced for both propellant and energetic applications; predict reactive material response to insult using an experimentally-validated multiscale model; accurately model the effects of microstructure on the dynamic response of energetic material composites; predict the burning rates of nitrate ester-based formulations with disruptive energetics additives; and extend computational models to adequately predict the behavior of three-dimensional (3D) solid propellants.			
Title: Lethal and Scalable Effects Technologies ***Description:*** This effort identifies and models preferred options to reduce energy/mass required to defeat emerging armor threats and to provide multi-purpose capabilities for revolutionary future lethality. In addition, this effort investigates technology options for scaling warhead lethality to enhance urban Warfighting capabilities including control of collateral damage. ***FY 2016 Accomplishments:*** Developed energy requirements and associated mechanisms to adapt large caliber performance to a shoulder fired system; investigated new mechanisms that take advantage of increased energy availability from enhanced gun efficiencies and new energetic materials to increase lethal capabilities; and explored new concepts to utilize lower energies on target to achieve effects ranging from non-lethal to lethal. ***FY 2017 Plans:*** Investigate new launch mechanisms that enable significant increases in muzzle energies using enhanced gun efficiencies (such as recoil and muzzle blast reductions) and new energetic materials; develop new mechanisms that take advantage of target vulnerabilities to reduce required energy levels to defeat specific targets; and develop physics-based simulations and experiments to explore new modular lethality concepts that efficiently redistribute available energy into multiple impacts / bursts. ***FY 2018 Plans:***	5.344	5.670	5.724

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will develop affordable, robust kinetic energy lethal capabilities for medium and large caliber cannons; explore next generation warhead concepts that can defeat multiple types of threat targets; continue developing game-changing concepts for cooperative, distributed, and/or modular lethality; and seek to explain non-lethal mechanisms.			
Title: Survivability/Lethality Analyses ***Description:*** This effort devises state-of-the-art survivability/lethality/vulnerability methodologies to dynamically model the interaction of conventional ballistic threats against future weapon systems. ***FY 2016 Accomplishments:*** Matured methodologies that characterize behind-helmet blunt trauma and assess the associated injury incapacitation probabilities for soldiers; matured predictive ammunition vulnerability methodologies (vulnerability to unintended ammunition detonation due to incoming round); matured tools, techniques, and methodologies for ballistic survivability/lethality analysis to ensure analysis tools are relevant and credible for developmental and modernized Army systems in their operational context; and conducted validation and verification of mature ballistic vulnerability and lethality codes ***FY 2017 Plans:*** Develop technically robust methodologies for characterizing the interactions between emerging threats and military targets to provide quantitative results to support formal evaluation of Army systems, design trade space examinations and milestone decisions; mature engineering-level system-of-systems methodologies that will provide leadership with a sound scientific understanding of the complex relationships between combat effectiveness, evolving technical and tactical threats, and Army systems. ***FY 2018 Plans:*** Will design, develop, and validate scientifically sound and user-friendly predictive methodologies for determining threat-target interaction outcomes for novel targets and threat mechanisms, to provide quantitative estimates for supporting formal evaluation of Army systems, design trade space examinations and milestone decisions; mature engineering-level complex systems methodologies that can run stand-alone or with humans in-the-loop; and provide system developers and decision makers with credible investigations of the complex relationships among new technologies, combat effectiveness, evolving threats, non-traditional military environments, and military systems.	9.920	8.273	7.473
Title: Multi-Threat Armor Formulations and Designs ***Description:*** This effort devises and matures multi-threat hybrid armor technologies incorporating both active and passive mechanisms for ground vehicle systems that are effective against future conventional weapons and evolving improvised threats. This research is coordinated with PE 0602601A (Armor Applied Research) and PE 0603005A (Combat Vehicle Survivability). ***FY 2016 Accomplishments:***	22.545	21.649	18.795

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Developed understanding of limiting mechanics of multiple impacts from advanced KE threats and expanded our functional library of defeat mechanisms that are independent of size, severity, or configuration regarding shaped charge equipped warheads; developed defeat concepts that greatly expanded protection from vast array of kinetic energy and shaped charge weapons; and continued support for transitions to the United States (U.S.) Army Tank Automotive Research, Development and Engineering Center (TARDEC) through PE 0602601A (Combat Vehicle and Automotive Technology) / Project C05 (Armor Applied Research) and PE 0603005A (Combat Vehicle and Automotive Advanced Technology) / Project 441(Combat Vehicle Mobility) as KE armors and warhead defeat mechanisms are matured. ***FY 2017 Plans:*** Develop novel passive and reactive armor protection concepts, including the use of promising materials technologies, to defeat a variety of current and future large caliber KE penetrators through further development of computational modeling and simulation capabilities and validation experiments; mature understanding and predictive multi-physics modeling capabilities of electromagnetic armor (EMA) and explosive reactive armor (ERA) to improve associated design tools and accelerate development; investigate stress wave propagation at dissimilar material interfaces through a combined experimental and computational approach to improve understanding of hybrid protection systems, in particular, multi-hit capabilities; and support transitions to the U.S. Army TARDEC through PE 0602601A / Project C05 and PE 0603005A / Project 441. ***FY 2018 Plans:*** Will develop hybrid armor concepts that optimize multiple mechanisms to include EMA and ERA, as well as new novel designs, to provide multi-threat defeat; experimentally validate promising passive and reactive armor concepts based on modeling and simulation efforts; conduct experiments using emerging threats against existing mechanistic designs; further develop experimental and computational modeling capabilities to enable multi-threat, multi-hit armor mechanism design and validation; determine physical mechanisms that contribute to multi-material armor design by increasing imaging and velocimetry diagnostic capability (i.e., measuring velocity) and design of novel experiments.			
Title: Adaptive and Cooperative Protection Technologies	-	2.795	6.393
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 (APS), and advanced soft kill methods into one solution to maximize survivability and minimize weight for combat and tactical vehicles. This research is coordinated with PE 0602601A (Armor Applied Research) and PE 0603005A (Combat Vehicle Survivability). ***FY 2017 Plans:***			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Assess current sensor/warner/tracker technologies that can warn of attack and identify threats of interest (such as Rocket-Propelled Grenades (RPGs)) and anti-tank guided missile (ATGM)); and explore multiple actuation technologies including mechanical actuation, energetic materials, and pulsed power in conjunction with selected counter measures. ***FY 2018 Plans:*** Will assess current sensor/warner/tracker technologies that can warn of attack and identify threats of interest (such as RPGs and ATGMs); and explore multiple actuation technologies including mechanical actuation, energetic materials, and pulsed power in conjunction with selected counter measures.			
Title: Ballistic and Blast Protection for Dismounted Soldiers ***Description:*** This effort develops unique physics-based models to understand the deflection and stress wave interactions with the human during the complex target interactions between threats and personal protective equipment (PPE). Use this knowledge framework to develop low technology readiness level (TRL) Personal Protective Equipment (PPE) concepts that are informed by the human effects during impact and blast events. ***FY 2016 Accomplishments:*** Explored novel helmet concepts that provide both ballistic and blunt trauma protection by incorporating understanding of ballistic impact on curved structures fabricated from structural composites; explored light fabric solutions for protection from secondary blast fragments; explored novel ceramic configurations for protection against advanced kinetic energy rounds; and developed computational methodologies to support development of these technologies. ***FY 2017 Plans:*** Develop computational models for hard and soft tissue to improve capabilities to develop new personnel protection concepts; develop improved biofidelic materials to improve experimental capabilities to assess Soldier protective systems; explore novel helmet concepts with new understanding of ballistic impact on curved structures; conduct experiments and develop models that combine protective helmet material concepts with human head models to improve fidelity of and validate helmet concepts. ***FY 2018 Plans:*** Will perform computational/experimental analysis of disruption mechanisms against legacy bullet technologies; simulate helmet/pad/head interaction for various loading scenarios; will investigate soft tissue and hard tissue injury mechanisms; will explore new concepts in limb protection from blast events.	3.653	6.561	6.700
Title: Soldier Lethality Technologies ***Description:*** This effort focuses on development of advanced lethal mechanisms, improved accuracy approaches, and leverages state-of-the-art materials to enable a single small arms cartridge for defeat of hard and soft targets and enable the defeat of combatants in defilade out to 2 km.	3.207	0.797	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
FY 2016 Accomplishments: Investigated concepts and validated models to achieve significantly higher muzzle velocities in small caliber weapons; and matured deeper understanding of novel concepts such as gun tube geometries, weapon dynamics, blast attenuation, impulse management, and transitional ballistics to enhance accuracy and lethality of small caliber weapons. ***FY 2017 Plans:*** Investigate concepts to enable high muzzle energies and multi-platform single-round warhead technologies in a light weapon system.			
Title: Warrior Injury Assessment Manikin (WIAMan) ***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. Transfer of responsibilities and funding from PE 0602787A (Medical Technology)/Project 869 (Warfighter Health Protection & Performance Standards, Army Medical Research and Materiel Command (MRMC) to ARL effective Fiscal Year (FY) 2015. This effort is coordinated with PE 0602601A (Armor Applied Research) and PE 0603005A (Combat Vehicle Survivability). ***FY 2016 Accomplishments:*** Completed validation and verification testing of the first whole-body WIAMan demonstrator; fabricated and integrated the WIAMan data acquisition system into the manikin; revised prototype manikin design and prepared technical data package for fabrication of the next generation prototype manikin and awarded fabrication contract; conducted program assessment milestone review; conducted injury medical research in a blast driven environment; transferred knowledge and tools for use in Live Fire Test and Evaluation and other under-body blast survivability efforts; and conducted research to establish human tolerance to the under-body blast loading environment and development of human injury probability curves. ***FY 2017 Plans:*** Validate data acquisition system/instrumentation suite for fabrication of next generation WIAMan technology demonstrator; assess biofidelity compliance; refine and validate finite element analysis model of the WIAMan technology demonstrator; and conduct biomechanical research for human injury probability curves for all body regions under consideration, including foot/ankle, lower leg, femur, pelvis, ribs/sternum, and spine. ***FY 2018 Plans:*** Will mature and assess the first data acquisition system components; will conduct design iterations to mature the WIAMan efforts from the Technology Demonstrator to a fully-integrated Generation-1 Prototype; begin to assess biofidelity, strength of design, and	14.076	8.808	6.446

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
technology readiness level of the Generation-1 Prototype; will commence injury biomechanics testing; and update and validate the finite element model.			
Title: Vulnerability Assessment of Technologies	8.390	8.706	8.840
Description: This effort reviews developmental technologies in the context of current and emerging threats, identifies tradeoffs, develops risk reduction and mitigation strategies, and promotes 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 determine vulnerabilities. This effort investigates, designs, and develops methods and tools and provides the oversight and coordination required to execute this research across the Army enterprise. This work complements and is coordinated with PE 0603125A (Combating Terrorism-Technology Development)/Project DF5 (Agile Integration & Demonstration). ***FY 2016 Accomplishments:*** Conducted vulnerability assessments on critical 6.2 (Applied Research) technologies based on Army priorities. These assessments identified very early-on, possible vulnerabilities and shortcomings of emerging technologies and influenced future Science and Technology (S&T) investment decisions resulting in the fielding of more robust systems. Candidate technologies were considered across all Army S&T portfolios. ***FY 2017 Plans:*** Complete analysis and reporting of findings for completed technology vulnerability assessments, including assessments of advanced sensor protection against future threats, advanced tactical networking technology, survivability implications of novel flight control concepts, assured positioning, navigation and timing in electronic warfare environments, advanced video processing technique, and sensing/warning capability against emerging unmanned aerial system threats; and initiate approved set of FY17 technology vulnerability assessments that are prioritized based on coordination across the S&T, intelligence, requirements and acquisition communities. ***FY 2018 Plans:*** Will conduct analysis and report findings of technology vulnerability assessments of developmental technologies that have high likelihood for maturation into future Army systems. Specific technologies for assessment in FY18 will be determined in FY17 and prioritized by a rigorous process based on coordination across the S&T, intelligence, requirements and acquisition communities. Findings will make systems employing these technologies more survivable and less expensive to acquire.			
Title: Active Protection Modeling and Technologies	6.782	3.217	5.407
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			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
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. This effort complements and is coordinated with PE 0602601A (Combat Vehicle and Automotive Technology)/Project C05 (Armor Applied Research), PE 0603004A (Weapons and Munitions Advanced Technology)/Project 232 (Advanced Lethality & Survivability Demo), PE 0603005A (Combat Vehicle Survivability and Automotive Advanced Technology)/Project 221 (Combat Vehicle Survivability), PE 0603270A (Electronic Warfare Technology)/Project K16 (Non-Commo ECM Technology Demo), and PE 0603313A (Missile and Rocket Advanced Technology) / Project 263 (Future Missile Technology Integration). ***FY 2016 Accomplishments:*** Developed ATGM flight models; conducted warhead damage experiments into larger threats with different warhead explosives; developed softkill countermeasure models; completed integration of softkill and hardkill components and controller algorithms into an overarching softkill/hardkill simulation; integrated results into Research, Development, and Engineering Command (RDECOM)-level APS simulations suite. ***FY 2017 Plans:*** Integrate warhead damage experimental data into more complex damage mechanisms to study ATGM threats; incorporate threat counter measures into simulations to assess potential counter-counter measures; and examine softkill/hardkill performance, modifying simulations as necessary. ***FY 2018 Plans:*** Will compare simulation and experimental results of softkill physical demonstrations; computationally investigate performance of layered hardkill concepts with adaptive protection mechanisms; and simulate counter-counter measures against specific hard-kill/ soft kill solutions.			
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 (GPS) denied environments) through the use of highly collaborative teaming and distributed intelligence, perception, estimation, and control theories and technologies. ***FY 2017 Plans:*** Develop new modeling and simulation capabilities to capture complex flight physics, such as non-linear flow phenomena, flight body dynamics for complex shape bodies, and rapid, extreme maneuvers; and develop novel nonlinear Guidance, Navigation, and Control (GNC) capabilities to enable cooperative control and extreme maneuverability. ***FY 2018 Plans:***	-	4.675	4.772

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will produce realistic models for targets in complex environments; will determine reduced-bandwidth communications strategy between vehicles; implement these navigation technologies in simple experiments (e.g., ground or air robots).			
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 2018 Plans:*** Will develop models to enable ability to perform concurrent armor concept and armor-material design.	-	-	1.005
Accomplishments/Planned Programs Subtotals	93.221	85.436	85.309

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602618A / *Ballistics Technology*	Project (Number/Name) HB1 / *SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
HB1: *SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)*	-	25.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

Note

Not applicable for this item.

A. Mission Description and Budget Item Justification

These are Congressional Interest Items

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017
Congressional Add: Program Increase ***FY 2016 Accomplishments:*** This is a Congressional Interest Item	20.000	-
Congressional Add: Improved Armor Technologies ***FY 2016 Accomplishments:*** This is a Congressional Interest Item	5.000	-
Congressional Adds Subtotals	25.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army	Date: May 2017
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602622A / *Chemical, Smoke and Equipment Defeating Technology*

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
Total Program Element	-	3.713	3.923	4.004	-	4.004	5.032	5.612	4.195	4.281	-	-
552: *Smoke/Novel Effect Mun*	-	3.713	3.923	4.004	-	4.004	5.032	5.612	4.195	4.281	-	-

A. Mission Description and Budget Item Justification

This Program Element (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 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, Project L97 (Smoke and Obscurants Advanced Technology) and PE 0603606A, Project 608 (Countermine & Barrier Development).

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.

This work is performed by the Army Research, Development, and Engineering Command (RDECOM), Edgewood Chemical Biological Center (ECBC), Edgewood, MD.

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	3.866	3.923	3.994	-	3.994
Current President's Budget	3.713	3.923	4.004	-	4.004
Total Adjustments	-0.153	0.000	0.010	-	0.010
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.153	-			
• Civ Pay Adjustments	0.000	0.000	0.010	-	0.010

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602622A / *Chemical, Smoke and Equipment Defeating Technology*	Project (Number/Name) 552 / *Smoke/Novel Effect Mun*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
552: *Smoke/Novel Effect Mun*	-	3.713	3.923	4.004	-	4.004	5.032	5.612	4.195	4.281	-	-

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 (IR) 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.

Work in this Project is related to, and fully coordinated with, PE 0603004A. Project L97 (Smoke and Obscurants Advanced Technology) and PE 0603606A, Project 608 (Countermine & Barrier Development).

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 in this Project is performed by the Army Research, Development, and Engineering Command (RDECOM), Edgewood Chemical Biological Center (ECBC), Edgewood, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Advanced Obscurants	1.370	1.468	1.518
Description: This effort investigates new materials and compounds to enable safe, effective screening of personnel and equipment.			
FY 2016 Accomplishments: Investigated spectrally selective materials and new microwave materials. Investigated materials for advanced bispectral obscurants.			
FY 2017 Plans: Will further investigate three advanced bispectral materials concepts. Will examine three promising spectrally selective materials mechanisms. Will investigate process scale up of new promising microwave obscurants in order to conduct future field trial experiments.			
FY 2018 Plans:			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602622A / *Chemical, Smoke and Equipment Defeating Technology*	**Project (Number/Name)** 552 / *Smoke/Novel Effect Mun*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will measure screening performance of top candidate bispectral materials. Will design and build a chamber to measure microwave obscurant performance.			
Title: Obscurant Enabling Technology ***Description:*** This effort investigates distribution technologies for various obscurants. This effort will support Modular Active Protection System (MAPS) in 0602601/C05 and 0603005/221. ***FY 2016 Accomplishments:*** Continued to study explosive dissemination variables to understand key factors such as obscurant dispersal. Continued to conduct vulnerability studies of various technologies to obscurant/target defeat effects. ***FY 2017 Plans:*** Will continue to investigate explosive dissemination factors and assess modeling and experimental concepts. Will initiate efforts on pneumatic dissemination of particulate obscurant materials. Will continue to conduct vulnerability studies of various technologies to obscurant/target defeat effects. ***FY 2018 Plans:*** Will evaluate performance of pneumatic dissemination against the performance of other distribution technologies. Will continue to conduct vulnerability studies of various technologies to obscurant/target defeat effects.	0.960	1.000	1.002
Title: Forensic Analysis of Explosives ***Description:*** This effort investigates forensics analytical methods for military explosives, homemade explosives (HME), HME precursors, and residue analysis for attribution. ***FY 2016 Accomplishments:*** Investigated the combination of microfluidics and surface enhance Raman spectroscopy (SERS) for the detection of explosives, drugs, and other molecules of interest for forensic analysis in biological fluids such as saliva, sweat and urine. ***FY 2017 Plans:*** Will investigate a proof of concept device based on microfluidics and SERS for the detection of explosives, drugs, and other molecules of interest for forensic analysis in biological fluids such as saliva, sweat and urine. Will investigate the potential of sensing explosives and other toxic chemicals using dielectric materials as part of a rudimentary circuit or system. ***FY 2018 Plans:***	1.383	1.455	1.484

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602622A / *Chemical, Smoke and Equipment Defeating Technology*	**Project (Number/Name)** 552 / *Smoke/Novel Effect Mun*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will investigate integrated photonics chips as a proof of concept device for the detection of explosives, drugs, and other molecules of interest for forensic analysis and wearable detectors; investigate a proof of concept device for the sensing explosives and precursor chemicals based on impedance using novel dielectric materials.			
Accomplishments/Planned Programs Subtotals	3.713	3.923	4.004

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602623A *I Joint Service Small Arms Program*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	5.270	5.545	5.615	-	5.615	5.576	5.687	5.801	5.919	-	-
H21: *Jt Svc Sa Prog (JSSAP)*	-	5.270	5.545	5.615	-	5.615	5.576	5.687	5.801	5.919	-	-

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.

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).

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.

This program is managed by the Army Armament Research, Development, and Engineering Center (ARDEC), Picatinny Arsenal, NJ, in collaboration with the Army Research Laboratory (ARL) at Aberdeen Proving Ground, MD.

B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	5.487	5.545	5.608	-	5.608
Current President's Budget	5.270	5.545	5.615	-	5.615
Total Adjustments	-0.217	0.000	0.007	-	0.007
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.217	-			
• Civ Pay Adjustments	0.000	0.000	0.007	-	0.007

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
H21: *Jt Svc Sa Prog (JSSAP)*	-	5.270	5.545	5.615	-	5.615	5.576	5.687	5.801	5.919	-	-

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.

Efforts in this Project support the Lethality portfolio.

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).

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 Armament Research, Development, and Engineering Center (ARDEC), Picatinny, NJ.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Weapon System and Enablers	1.683	1.860	1.881
Description: This effort investigates and evaluates small arm 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 2016 Accomplishments: Investigated and evaluated advanced materials, coatings and weapon system designs in order to reduce weight, mitigate recoil, and decrease weapon signature; matured suppressor designs to reduce gun flash and acoustic signatures; investigated futuristic small arms weapon systems proposed by the West Point Futures Study and generated technology plans, trade-off analyses, and concept gun designs.			
FY 2017 Plans:			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602623A / *Joint Service Small Arms Program*	**Project (Number/Name)** H21 / *Jt Svc Sa Prog (JSSAP)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Investigate and assess technologies to improve the accuracy and controllability of the weapon with the Soldier-in-the loop, and facilitate the operation of the weapon system with novel or advanced ammunition concepts required to meet lethality requirements. ***FY 2018 Plans:*** Will design and develop active stabilization technologies to increase hit probabilities and advance next generation fire control technologies; investigate high pressure weapon operation cycling for increase ammunition terminal performance and increase speed to target engagements; mature precision munitions components to increase probability of incapacitation against near and far term enemy threats; develop new techniques for evaluating and improving the reliability of weapon systems with the end goal of increasing the Mean Rounds Between Failure (MRBF) and Mean Rounds Between Stoppages (MRBS); and investigate technologies to increase weapon reliability/durability through use of advance coatings which will reduce or eliminate the need for conventional lubricants in weapon action components; design and develop a small arms barrel characterization tool to determine optimal weapon thermal loading, heat input, bore stresses, and chemical, thermal, mechanical erosion.			
Title: Small Arms Ammunition Research ***Description:*** This effort addresses the design and evaluation of ammunition with reduced weight, signature, fouling and contaminants as well as improved terminal performance and improved performance against soft and hard targets. ***FY 2016 Accomplishments:*** Investigated and evaluated ammunition designs in order to increase probability of hit and probability of incapacitation/hit; optimized caliber and configuration to defeat personnel targets at extended ranges, with or without protection; conducted trade studies to support energetic materials for propulsion, breaching ammo and tagging and marking; designed, fabricated and evaluated advanced armor piercing 5.56 mm and advanced kinetic energy ammunition in collaboration with ARL. ***FY 2017 Plans:*** Investigate and assess ammunition propulsion technologies to increase muzzle velocity that meet safety constraints (noise and muzzle pressure) yet increase velocity/muzzle energies like launch mechanisms (sabot, taper bore, etc); improve propellant higher energy densities; introduce compact cartridges; and lighten cartridge weight; improve ammunition projectiles to reduce energies required to perforate toughest targets and implement highly efficient aerodynamics. ***FY 2018 Plans:*** Will design and develop ammunition technologies to support precision ammunition requirements for extended range, accuracy and terminal effects required to perforate toughest targets and implement highly efficient aerodynamics. These technologies will support the development of next generation small arms ammunition.	1.218	3.046	3.079
Title: Optics and Fire Control	1.768	-	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602623A / *Joint Service Small Arms Program*	**Project (Number/Name)** H21 / *Jt Svc Sa Prog (JSSAP)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Description: This effort investigates and evaluates optics and fire control technologies in order to provide a single ballistic solution to the Warfighter. Fire control devices include a laser range finder to determine the range of a target, a ballistic sensor to detect the position of the weapon system, and sensors that can measure local and downrange conditions that would affect the trajectory of a round. ***FY 2016 Accomplishments:*** Investigated and evaluated hardware and software component technologies for an enhanced ballistic computer that enables fire on the move trajectory correction and increased precision at longer ranges, wind and improved environmental sensing, and improved target identification.			
Title: Small Arms Technology Applied Research ***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. ***FY 2016 Accomplishments:*** Evaluated state-of-art small arms technologies components to determine maturity for system integration; investigated small arms technologies capabilities to defeat current and future threats to the dismounted warfighter; conducted extensive analysis of available worldwide small arms systems and component technologies; leveraged small arms knowledge to better focus applied research efforts in support of Army small arms capabilities. ***FY 2017 Plans:*** Evaluate state-of-art small arms technologies components to determine maturity for system integration; investigate small arms technologies capabilities to defeat current and future threats to the dismounted warfighter; conduct extensive analysis of available worldwide small arms systems and component technologies; leverage small arms knowledge to better focus applied research efforts in support of Army small arms capabilities. ***FY 2018 Plans:*** Will investigate and mature a high pressure operating system capability to defeat current and future threats to the dismounted warfighter; investigate active stabilization technologies integrated with advance next generation fire control technologies to increase hit probabilities, increase kinetic speed to target and decrease engagement time; develop scalable precision munition technologies to a Technical Readiness Level (TRL) 4 to increase Warfighter capability in anti-materiel, anti-personnel and other specialized missions; develop to a TRL5 a Reduced Range Training Ammunition (RRTA) for reduced Surface Danger Zones	0.601	0.639	0.655

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602623A / *Joint Service Small Arms Program*	**Project (Number/Name)** H21 / *Jt Svc Sa Prog (JSSAP)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
(SDZ) ranges with a trajectory match to current combat ammunition; develop a system and method, both accurate and repeatable, to measure blowback produced by small caliber suppressors.			
Accomplishments/Planned Programs Subtotals	5.270	5.545	5.615

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602624A *I Weapons and Munitions Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	81.447	53.581	41.455	-	41.455	48.825	58.018	57.427	67.124	-	-
H18: *Weapons & Munitions Technologies*	-	20.154	21.749	21.455	-	21.455	20.900	23.620	17.425	19.791	-	-
H19: *Asymmetric & Counter Measure Technologies*	-	12.689	14.924	5.353	-	5.353	4.558	6.401	9.449	11.769	-	-
H1A: *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE*	-	35.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-
H28: *Warheads/ Energetics Technologies*	-	13.604	16.908	14.647	-	14.647	23.367	27.997	30.553	35.564	-	-

A. Mission Description and Budget Item Justification

This Program Element (PE) investigates, designs and evaluates enabling technologies to develop lethal and nonlethal 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 the weapons lethality. Project H28 evaluates munition components such as fuzes, power, warheads with tailorable effects, and insensitive munition compliant energetic materials.

Work in this PE is related to, and fully coordinated with, PE 0602303A (Missile Technology), PE 0602105A (Materials Technology), PE 0602618A (Ballistics Technology), PE 0602772A (Advanced Tactical Computer Science and Sensor Technology), PE 0602782A (Command, Control, Communications Technology), and PE 0603004A (Weapons and Munitions Advanced Technology).

The cited work is consistent with the Lethality Portfolio and the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Work in this PE is primarily performed by the Armament Research, Development, and Engineering Center (ARDEC) at Picatinny Arsenal, NJ, in cooperation with the Army Research Laboratory (ARL) at Aberdeen Proving Ground, MD; the Communications-Electronics Research, Development, and Engineering Center (CERDEC), Fort Belvoir, VA; the Tank Automotive Research, Development, and Engineering Center (TARDEC), Warren, MI; and the Aviation and Missile Research, Development, and Engineering Center (AMRDEC), Huntsville, AL.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army					Date: May 2017
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*		**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*			
B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	83.340	53.581	50.022	-	50.022
Current President's Budget	81.447	53.581	41.455	-	41.455
Total Adjustments	-1.893	0.000	-8.567	-	-8.567
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.893	-			
• Adjustments to Budget Years	0.000	0.000	-8.666	-	-8.666
• Civ Pay Adjustment	0.000	0.000	0.099	-	0.099

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2016**	**FY 2017**
Project: H1A: *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE*		
Congressional Add: *Program Increase*	35.000	-
Congressional Add Subtotals for Project: H1A	35.000	-
Congressional Add Totals for all Projects	35.000	-

Change Summary Explanation

Fiscal Year (FY) 2018 funding decreased to support higher priority efforts.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602624A / *Weapons and Munitions Technology*	Project (Number/Name) H18 / *Weapons & Munitions Technologies*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
H18: *Weapons & Munitions Technologies*	-	20.154	21.749	21.455	-	21.455	20.900	23.620	17.425	19.791	-	-

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, and for protection of platforms.

Efforts in this Project support the Army Science and Technology Lethality Portfolio.

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 in this Project is performed by the Armament Research, Development, and Engineering Center (ARDEC), at Picatinny Arsenal, NJ (in collaboration with a the Army Research Laboratory (ARL), Aberdeen Proving Ground, MD; the Aviation and Missile Research, Development, and Engineering Center (AMRDEC), Huntsville, AL; and the Communications-Electronics Research, Development, and Engineering Center (CERDEC), Fort Belvoir, VA.)

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Novel Propulsion Technology for the Future	3.707	3.388	3.429
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 2016 Accomplishments: Conducted evaluation of extended range 120mm mortar fire in a round designed to double (2x) the range; produced co-extruded gun propellant for direct and indirect fire applications; performed 30mm fires of coated propellant for improved ballistic performance and extended range with lower sensitivity to temperature; increased the burn rate at low temperature and maintained high temp burn rate resulting in more range over the temp spectrum and increased accuracy due to less propellant variation; formulated new materials for extended range artillery applications.			
FY 2017 Plans: Evaluate novel and innovative gun propellant materials for the implementation of three-dimensional (3D) printed charge development; develop next generation charge concepts and prototypes using 3D printing technology for medium caliber up to			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H18 / *Weapons & Munitions Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
large caliber charges for tank, artillery and mortar systems; develop engineering tools to design and model 3D printed charges using the novel materials and novel charge concepts. ***FY 2018 Plans:*** Will optimize formulation and design electrode configurations for electrically controlled energetic materials (ECEM) which could enable extended range and improve precision and temperature compensation; design and develop igniter materials and characterize interaction between coated propellant grains and ignition system in development of a temperature invariant propulsion system; conduct experiments to transform feed stock propellant formulations into spheroidal geometries using advanced processing techniques; mature the die design and formulation developed organically for co-extrusion processing; mature novel propellant formulations and validate models and experiments while investigating increased propellant masses for use in co-developed foam celluloid combustible case; continue to investigate, research, and mature new rocket motor formulations for use in emerging rocket assisted projectiles to determine potential range increases.			
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. ***FY 2016 Accomplishments:*** Investigated innovative weapon technologies that could provide lethality improvements such as nanostructured materials for high strain rate applications and counter unmanned aerial systems (UAS) system analysis; developed weapon technologies that incorporate new materials (e.g. nanotechnology, additive manufacturing); developed weapon, munition and fire control technologies that support advanced forms of engagement, such as collaborative multi-role weapons and munitions. ***FY 2017 Plans:*** Investigate novel weapon technologies that provide lethality improvements in confined, complex, constrained environments; investigate aviation armament technologies that support lighter, more lethal armaments for the family of rotary wing aircrafts. ***FY 2018 Plans:*** Will investigate novel weapon technologies that will allow for heat check techniques of cracks in explosives; conduct experiments to develop cold spray deposition processes for erosion resistant metal coatings.	1.354	1.497	0.824
Title: Extended Range Projectile Technology ***Description:*** This effort develops various methods of low cost extended range technologies for mortar and artillery applications. Projectile lift and surface control technologies will be investigated for survivability and functionality through component level	0.949	-	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H18 / *Weapons & Munitions Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
research and modeling and simulation. The Warfighter will be able to use these technologies coupled with handheld devices to engage Beyond Line-of-Sight (BLOS) targets and guide the projectile in flight. ***FY 2016 Accomplishments:*** Investigated hybrid (155mm projectile with the incorporation of base fins and lifts/control surfaces) technologies for artillery indirect fire application; designed control surfaces to achieve extended ranges; conducted bench top testing of control actuation mechanisms such as (power sources, motors and canards) capable to maintain structural integrity.			
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 2016 Accomplishments:*** Completed subsystem evaluation of the optics to include laying out the tactical imager and electronics form factor as well as begin high-g survivability testing of the optics; performed evaluation of the image processing navigation algorithm using the modeling and simulation developed. This effort was conducted in collaboration with AMRDEC through the Aided Target Recognition (ATR) Working Group and with ARL personeel through a technology transition agreement. . ***FY 2017 Plans:*** Validate the algorithm development for the imager based terminal guidance concepts through extensive modeling and simulation efforts; conduct experiments in order to verify the survivability and maturity of the candidate imager technologies in a high G environment. ***FY 2018 Plans:*** Will characterize thoroughly the image navigation component and subsystem technologies across the operational conditions in order to ensure a robust Technology Readiness Level 5 (TRL-5) is achieved for all of the enabling subsystems; a new low Size, Weight, and Power (SWaP) Tactical Grade Gun Hardened Inertial Measurement Unit (IMU) will be demonstrated to a TRL-5.	2.570	2.962	3.015
Title: Enabling Printed Explosives, Power Sources & Electronics for Munitions ***Description:*** This effort designs and evaluates the state-of-the-art in materials printing, direct write, flexible electronics, and conformal systems for the Warfighter. ***FY 2016 Accomplishments:*** Investigated, designed and adopted commercial-off-the-shelf (COTS) hardware to print electronics and energetics for use in munitions and power sources for munitions and other armament applications; established materials and printing techniques to add capabilities to munitions and fuze systems, while reducing the size, weight, and cost of conventional electronics; conducted	0.718	-	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H18 / *Weapons & Munitions Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
experiments to determine applicability of printing techniques for antennas, sensors, electrical components, and other components printed onto windscreens, radomes, munitions, and weapon systems. This effort was conducted in collaboration with CERDEC, AMRDEC and ARL through both an integrated project team and technical working groups.			
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. ***FY 2016 Accomplishments:*** Matured the concepts of an extended range armament system; conducted initial verification of models through lab scale prototypes designs and testing; and evaluated the various technology concepts based on the capabilities the integrated system provides. ***FY 2017 Plans:*** Mature and integrate extended range armament component technologies further; continue to validate technology concepts in an integrated environment to assess impacts to current systems; determine technologies that provide weight reduction potential while supporting increased velocities needed for ranges beyond the current capability of self-propelled artillery (M109A7) howitzer. ***FY 2018 Plans:*** Will continue to mature extended range indirect fire component technologies and conduct integrated experiments to validate technologies for use with the M109A7 howitzer system to determine system impacts of the extended range capability as well as investigate the application of these technologies to other indirect fire systems such as the M777A2 and M119A3.	2.197	2.814	2.783
Title: Force Protection Technologies ***Description:*** This effort accelerates the development of disruptive technologies that enable transformational protection capabilities for vital assets, forces and civilian populations, increasing safety, decreasing collateral damage and minimizing fratricide. ***FY 2016 Accomplishments:*** Investigated and designed armament technologies to provide protection to vehicles, facilities, weapons, and personnel; developed precision weapons, munitions and fire control technologies to reduce collateral damage to non-combatants while providing greater standoff distance between incoming threats and vital assets. ***FY 2017 Plans:***	3.374	0.588	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H18 / *Weapons & Munitions Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Investigate and develop armament technologies capable of providing non-kinetic, High-Powered /Radio Frequency Directed Energy, lethal effects against Unmanned Aerial systems, precision Rocket, Artillery, Mortar and other potential threats.			
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. Resulting component technologies will be evaluated and matured in the fully coordinated effort of the same name in PE/Project 0603004A/232. ***FY 2016 Accomplishments:*** This effort was conducted in concert with the Extended Range Indirect Fire Weapon Technology effort mentioned above. These new technologies were applied to light weight common armament, advanced micro-common fire control, novel post launch propulsion methods, and advanced projectile lifting surfaces. ***FY 2017 Plans:*** This effort is being conducted in concert with the Extended Range Indirect Fire Weapon Technology effort; determine weight reduction of common 155mm armament concepts integrated with advanced micro-common fire control concepts to achieve extended range for demonstration mentioned in PE/Project 0603004A/232; validate post launch propulsion methods for next generation extended range munitions and determines range extension gains achieved by post launch lifting surfaces. ***FY 2018 Plans:*** This effort will be conducted in concert with the Extended Range Indirect Fire Weapon Technology effort to determine weight reduction of common 155mm armament concepts integrated with advanced micro-common fire control concepts to achieve extended range for demonstration mentioned in PE/Project 0603004A/232; validate post launch propulsion methods for next generation extended range munitions and determine range extension gains that could be achieved by new designs of post launch projectile lifting surfaces.	3.363	2.500	1.500
Title: Fuze and Power Technologies for Munitions ***Description:*** This effort investigates and designs innovative fuze and power technologies for enhanced environment and target sensing/classification, warhead initiation schemes and advanced fuze setting to provide enhanced lethality combined effects on targets and advanced initiation schemes for the next generation munitions. ***FY 2016 Accomplishments:*** Explored robust airburst fuze technology concepts for increased accuracy in multi-purpose rounds; developed microscale sensor concepts and devices for enhanced environment sensing and for arming and warhead initiation in which all the energetic components are out-of-line; investigated alternative fuze setting methodologies to more efficiently transfer and store power and data to smart indirect fire projectiles; investigated multi-point initiation concepts applicable for Insensitive Munitions	1.922	2.000	2.080

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H18 / *Weapons & Munitions Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
applications; investigated innovative munitions power source candidate technologies for medium and large caliber munitions. These technologies supported the Joint Munitions Program Technical Coordinating Group (TCG – 5 and TCG-10) and the Joint Fuze Technology Program (JFTP). ***FY 2017 Plans:*** Continue to design and develop robust airburst fuze technology concepts for increased accuracy in multi-purpose rounds; mature micro-scale sensor components and devices for enhanced environment sensing and for arming and warhead initiation in which all the energetic components are both in and out-of-line; validate alternative fuze setting methodologies to more efficiently transfer and store power and data to smart indirect fire projectiles; mature multi-point initiation components applicable to Insensitive Munitions; validate innovative munitions power source technologies for medium and large caliber munitions. These technologies will continue to support the Joint Munitions Program Technical Coordinating Group (TCG – 5 and TCG-10) and the JFTP. ***FY 2018 Plans:*** Will continue to mature advanced sensor components and devices; mature advanced initiation systems applicable to insensitive munitions; mature and validate advanced power technologies for medium and large caliber munitions; and mature airburst fuzing technologies for reduced range error in medium caliber fuzing. These technologies will continue to support the Joint Munitions Program TCG – 5 and TCG-10 and the JFTP.			
Title: Cluster Munitions Replacement Acceleration ***Description:*** This effort will design and develop the critical components that will aid in the maturation of a materiel solution designed to replace 155mm dual purpose improved conventional munition (DPICM) artillery. The components will include the design, development and component testing of fuzing, warhead and stabilization technologies. ***FY 2017 Plans:*** Effort investigates high reliability DPICM technologies, design and develop high reliability fuzing architectures in a small, self-contained form factor; assign component space allocation including investigation of fuze component level technologies, stabilizer design and development and mature warheads. Continue to develop advanced unitary warhead designs and to further design and establish warhead initiation requirements and compatibility with existing artillery fuze designs. Develop and mature critical components leveraging lessons learned from prior cluster munition replacement component testing. ***FY 2018 Plans:*** Will investigate and mature fuze initiation train design; research and develop novel designs of arming, warhead and stabilization architectures; conduct lab experiments for critical components to validate reliability and functionality claims; fund research looking at the effectiveness of materiel solutions for various concepts.	-	6.000	7.000
Title: Programmable Intelligent Collaborative Engagement Munition	-	-	0.824

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H18 / *Weapons & Munitions Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
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. ***FY 2018 Plans:*** Will develop collaborative algorithms, which will include a set of tools like target assignment based on probability of kill scoring, target assignment with must hit priority where total probability of kill priority is applied after must hit criteria are achieved, and 3D pattern goals with arrival time objectives.			
Accomplishments/Planned Programs Subtotals	20.154	21.749	21.455

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
H19: *Asymmetric & Counter Measure Technologies*	-	12.689	14.924	5.353	-	5.353	4.558	6.401	9.449	11.769	-	-

A. Mission Description and Budget Item Justification

This Project designs and develops technologies to support asymmetric countermeasures such as radio frequency and ultra-short pulse directed energy and 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 Program Element (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 Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

This work is performed by the Armament Research, Development, and Engineering Center (ARDEC), at Picatinny Arsenal, NJ, and the Army Research Laboratory (ARL) at Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Novel Battlefield Effectors	1.684	2.359	-
Description: This effort investigates unique weapon and munitions enabling technologies to achieve tunable effects on targets and that are capable of providing a full range of effects from non-lethal to highly lethal via a single weapon or munition. ***FY 2016 Accomplishments:*** Investigated the most promising effector technologies such as Hostile Fire Detection, Mortar Blast Attenuation, and Counter-Counter Measure. Technologies were ready for transition to advanced development. Investigated size, weight, power and cost benefits of these technologies in new applications; explored the use of disruptive technologies that could be applied to current and future precision guided direct and indirect fired munitions. ***FY 2017 Plans:*** Investigate novel technologies capable of improving ammunition development and demilitarization throughout the life cycle; provide counter-countermeasure technologies for advanced development; explore the use of disruptive technologies that can be applied to current and future munitions and armament systems.			
Title: Counter-Countermeasure (CCM) Technologies for Weapons and Munitions	1.388	1.463	1.309

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
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*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Description: This effort investigates guidance signal reduction, inertial measurement unit, and antenna design technologies to enable continued effectiveness of US weapon systems against enemy countermeasures including Active Protection Systems (APS), Global Positioning System (GPS) jamming, and active seeker jamming. ***FY 2016 Accomplishments:*** Conducted experimentation of CCM technologies for gun launched munition components in a relevant laboratory environment. ***FY 2017 Plans:*** Validate high power antenna array concept designs that offer size, weight, and power (SWaP) reduction; investigate scalability of novel technologies for various potential applications such as vehicle stopping, counter electronics and counter Unmanned Aeriel Systems (UAS); continue to design and develop innovative technologies for compact solid state high power radio frequency sources. ***FY 2018 Plans:*** Will mature technologies providing active counter-countermeasures against radio frequency (RF) threats; develop advanced materials for passive protection and structural enhancements; conduct designs of experiments to isolate key variables for design enhancements; integrate technologies for performance characterization against simulated threats.			
Title: Enhanced Fire Control for Indirect Fires ***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. ***FY 2016 Accomplishments:*** Evaluated and integrated acquisition and engagement technologies which supported extended range indirect fire systems such as: extended range tracking and sizing capabilities, advanced sensors, hardware prototyping and firmware coding technologies for use in GPS-denied environments; navigation and pointing technologies/compensation techniques; conventional munition accuracy and reduced navigational burden for smart munitions technologies; communication techniques for in-flight interface/ control with smart munitions; investigated miniaturized and multifunctional electronic components to reduce SWaP-C, and increased commonality of hardware, software and operation across indirect fire systems; performed architecture trade-off analyses that allowed for efficient, real-time fusion of information and data. ***FY 2017 Plans:***	1.921	2.000	2.044

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
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*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Further mature extended range tracking and miniaturization of components for use in GPS-denied environments as well as further mature navigation and pointing technologies/compensation components; validate improved conventional munition accuracy and communication techniques for in-flight interface/control with smart munitions. ***FY 2018 Plans:*** Will mature extended range tracking, in flight communications and miniaturization of components for use in GPS-denied environments as well as navigation and pointing technologies/compensation components; validate improved conventional munition accuracy and develop common graphical user interfaces for fire control systems to allow for cross platform use and enable multi-role functionality.			
Title: High Powered Radio Frequency ***Description:*** This effort in High Power RF technology focuses on addressing the SWaP-C of High Power RF systems and their components so as to allow tactically useful systems. ***FY 2016 Accomplishments:*** Investigated high dielectric constant composites (nano-dielectrics) to achieve the desired size reduction of the high power antenna array to include validation; designed, fabricated and evaluated transistor technologies, such as laterally diffused metal oxide semiconductor (LDMOS) field-effect transistors, for highly efficient solid state transmitter applications. ***FY 2017 Plans:*** Validate antenna array at high power and prove SWaP reduction; investigate scalability of nano-dielectric technology to alternate frequency ranges for various potential applications such as vehicle stopping, counter electronics, counter UAS, etc.; continue design and development of innovative technologies for compact solid state high power radio frequency sources, leveraging advances in gallium nitride switches, nano-dielectrics, and/or efficient transistors.	1.927	2.002	-
Title: Terrain Shaping Munition Technologies ***Description:*** This effort develops an improved munition capability, remote delivery, and man-in-the-loop control technologies that will allow the warfighter to maintain dominance in the battlefield by denying adversaries access to an area of operations. ***FY 2016 Accomplishments:*** Investigated munition technologies including: large area coverage anti-personnel and dual mode warhead designs, directed energy vehicle defeat effects for low hazard protection of area denial munitions, and munition configurations; and investigated different designs of tamper deterrence and anti-tamper technologies such as obscuration and non-lethal technologies. ***FY 2017 Plans:***	1.921	2.000	2.000

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
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*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Investigate and develop new methods for generation of very high voltages via chemical, capacitive and explosive means, production of pulse/waveform against targets, and delivery of energies into targets by direct injection or remotely. ***FY 2018 Plans:*** Will validate munition architectures across delivery ranges against safety, reliability, and performance requirements; conduct experiments of large area coverage anti-personnel effects; investigate and confirm design with use of new dielectric and de-poling materials and conduct experimentations to validate different configurations and field layouts capable of handling high voltages in very compact form factor; collect validation data for effects study to identify output requirement and design tuning; conduct study on delivery mechanisms; and provide data for improving performances.			
Title: Small Arms Fire Control ***Description:*** This effort focuses on providing the soldier a set of small arms capabilities to increase the accuracy at extended ranges, probability of hit, improve time of engagement, and enhance situational awareness. By achieving these objectives, the soldier will be able to improve their operational effectiveness in reduced time. ***FY 2016 Accomplishments:*** Investigated advanced materials and technologies that optimize small arms fire control architecture at a reduced weight; developed and assessed advanced small arms technologies for improved target handoff; evaluated technologies that detect and provide threat indicators and potential targets; investigated technologies that recognize/classify and identify targets, aid in accurately aiming the weapon for effective firing and allow the soldier to assess conditions after firing for potential reengagement. ***FY 2017 Plans:*** Investigate technologies to increase probability of hit, including ballistic corrections for advanced sensor data including down-range wind sensing, target tracking and handoff at the individual-weapon platform, and moving target aim correction.	3.848	4.200	-
Title: Indirect Fire Aiming Techniques ***Description:*** This effort supports future integrated aiming technologies for indirect fires with enhanced capabilities and a simplified user interface while reducing size, weight and power. ***FY 2017 Plans:*** Investigate various innovative technologies to provide high fidelity location and orientation coordinates for use in indirect-fire applications; analyze technologies that can both provide these capabilities and reduce size, weight and power consumption for the next generation of fire control systems.	-	0.900	-
Accomplishments/Planned Programs Subtotals	12.689	14.924	5.353

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
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)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
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*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
H1A: *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE*	-	35.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

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 2016	FY 2017
Congressional Add: Program Increase	35.000	-
FY 2016 Accomplishments: Program increase for weapons and munitions technology research.		
Congressional Adds Subtotals	35.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602624A / *Weapons and Munitions Technology*	Project (Number/Name) H28 / *Warheads/ Energetics Technologies*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
H28: *Warheads/ Energetics Technologies*	-	13.604	16.908	14.647	-	14.647	23.367	27.997	30.553	35.564	-	-

A. Mission Description and Budget Item Justification

This Project investigates and designs enabling warhead and energetic technologies such as novel warhead architectures, 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 Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

This work is performed by the Army Armament Research, Development, and Engineering Center (ARDEC), at Picatinny Arsenal, NJ in collaboration with the Army Research Laboratory (ARL) at Aberdeen Proving Ground, MD; and the Aviation and Missile Research, Development, and Engineering Center (AMRDEC), Huntsville, AL.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Scalable Warhead Technology	5.699	5.931	5.250
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.			
FY 2016 Accomplishments: Designed and developed multi-functional warheads for multi-role missions that include Counter-Rocket, Artillery, and Missile(C-RAM), Counter-Unmanned Aircraft Systems(C-UAS) and anti-vehicle/personnel. Designed and tested brass board designs for shaped charge, explosively formed penetrator (EFP) and blast fragmentation with targeted lethality; determined, through modeling and simulation, the applicability of tunable/tailorable effects for adaptable warheads for future artillery, mortars and medium caliber munitions.			
FY 2017 Plans: Design and test brass board designs for shaped charge, EFP and blast fragmentation with targeted lethality; determine tunable/ tailorable effects for adaptable warheads through modeling and simulation. After successful testing at the component level, apply			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H28 / *Warheads/ Energetics Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
designs to warhead subsystem for validation. In addition, investigate novel concepts of area clearance capabilities with focus on the advancement of new warheads, line charge materials and fills while reducing collateral damage and maintaining or increasing effectiveness on target. ***FY 2018 Plans:*** Will mature warheads to higher levels of technology readiness through the iterative design and development process and will validate previous work in modeling and simulation. Among these are novel designs that can enable multi-role munitions (e.g. C-RAM, C-UAS) such as shaped charge (SC) and multi explosively formed penetrators (MEFP's) to be developed to address emerging threats. In addition, further designs in controlled and scalable blast fragmentation will be pursued to concentrate lethality while reducing collateral damage. Will continue the design process to provide lethality solutions to cluster munition replacements as well as continue maturing novel area clearance concepts; validate component technologies in a relevant environment.			
Title: Explosives Research ***Description:*** This effort develops high energy/high performance, multi-purpose insensitive munitions (IM) explosives. ***FY 2016 Accomplishments:*** Investigated single step nano-enhanced explosive munitions with greatly reduced shock sensitivities; validated lethality and fragmentation concepts; investigated scale up high pressure synthesis chemistry of disruptive energetic materials; validated high efficiency explosive concepts in munition systems. This effort was conducted in collaboration with ARL through both the integrated project team and technical working groups. ***FY 2017 Plans:*** Investigate synthesis and formulation of advanced energetic materials for low sensitivity and higher performance applications; advance and develop the use of meso-scale reactive flow models to further understand energetics performance as well as energetics sensitivity as it relates to initiation behavior to unplanned stimuli; research materials and processes to enable energetic inks and energetic powder deposition for application to additive three-dimensional (3D) printed energetic parts and devices; investigate the advancement of developing novel nano-energetic formulations to provide substantially less shock sensitivity than current formulations; research synthesis and processing of new materials using novel techniques such as Advanced Flow Reactors (AFR) technology for processing energetic materials in a timely, safe and efficient manner; further research and validate tailored energy release technology for demonstration of electrical on/off energetic capabilities and chemistry-based variable warhead fragmentation; investigate unique disruptive and scalable technologies in collaboration with ARL. ***FY 2018 Plans:*** Will conduct research to investigate a new class of energetic materials, amorphous energetics, capable of on-demand activation for improved sensitivity and performance; will investigate the synthesis of energetic materials tailored to additive manufacturing	4.926	7.877	6.349

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H28 / *Warheads/ Energetics Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
applications; design explosives charges with integrated electronics; model next-generation gun-propulsion charge design concepts achievable as a result of additive manufacturing capabilities; conduct research with advanced processing methods to synthesize energetic materials in safer, more efficient and environmentally-conscious manners.			
Title: Tunable Pyrotechnics ***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. ***FY 2016 Accomplishments:*** Refined dazzler countermeasure (CM) formulations along with additional flight testing. Refined dazzler modeling and simulation (M&S) algorithms as well; cloud countermeasure undergoing final prototype design formulation in full up system level demonstrations on aircraft; updated M&S algorithms for cloud countermeasure; tested advanced countermeasure initial formulations and flare concepts against hardware in the loop threat seekers; developed digital M&S algorithms. ***FY 2017 Plans:*** Finalize formulation and prototype design for dazzler CM for night time solution; perform M & S studies to evaluate if requirements can be met; produce scaled-up quantities for cloud countermeasure for two different flare formulations; conduct flight tests and evaluate effectiveness; transition cloud CM to Engineering Manufacturing Development (EMD) phase; down select from initial formulations of advanced seeker counter-measures (ASCM) and design prototypes for further maturation and demonstration. ***FY 2018 Plans:*** Will integrate and test designs for dazzler CM for both night time and day time solutions; refine M&S for reliability to evaluate if requirements can be met; produce scaled-up quantities for cloud countermeasure for down selected flare formulations; investigate and verify effectiveness of formulations; mature formulations of ASCM to obtain effectiveness data; validate cloud CM to Technology Readiness Level 5 (TRL-5).	2.979	3.100	2.048
Title: Novel Demilitarization Technologies ***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 ***FY 2018 Plans:*** Will investigate contained release agents for weapons demilitarization; design demilitarization-ready ammunition using embedded agents that will modify explosives on-demand and will render munitions safe and unusable for military purposes.	-	-	1.000
Accomplishments/Planned Programs Subtotals	13.604	16.908	14.647

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H28 / *Warheads/ Energetics Technologies*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602705A / *Electronics and Electronic Devices*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	62.654	56.322	58.352	-	58.352	59.780	61.345	63.424	64.963	-	-
EM4: *Electric Component Technologies (CA)*	-	9.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-
EM8: *High Power And Energy Component Technology*	-	11.673	11.416	10.632	-	10.632	14.263	14.873	15.653	15.943	-	-
H11: *Tactical And Component Power Technology*	-	11.353	8.714	8.332	-	8.332	7.652	7.850	8.048	8.215	-	-
H17: *Flexible Display Center*	-	1.091	2.356	2.143	-	2.143	1.200	0.752	0.301	0.313	-	-
H94: *Elec & Electronic Dev*	-	29.537	33.836	37.245	-	37.245	36.665	37.870	39.422	40.492	-	-

A. Mission Description and Budget Item Justification

This Program Element (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 0602709A (Night Vision Technology), PE 0602782A (Command, Control, Communications Technology), PE 0602783A (Computer and Software Technology), PE 0603001A (Warfighter Advanced Technology), and PE 0603772A (Advanced Tactical Computer Science and Sensor Technology).

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 Army Research Laboratory, Adelphi, MD. and the Army Communications-Electronics Research, Development, and Engineering Center, Aberdeen Proving Ground, MD.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army	Date: May 2017
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*

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	64.301	56.322	58.884	-	58.884
Current President's Budget	62.654	56.322	58.352	-	58.352
Total Adjustments	-1.647	0.000	-0.532	-	-0.532
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.647	-			
• Adjustments to Budget Years	0.000	0.000	-0.786	-	-0.786
• Civ Pay Adjustments	0.000	0.000	0.254	-	0.254

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2016	FY 2017
Project: EM4: *Electric Component Technologies (CA)*		
Congressional Add: *Silicon Carbide (SiC) Research-Army Research Laboratory*	3.600	-
Congressional Add: *Advanced Intelligent Battery Eliminator / Lithium-ion Capacitor Material Research, Electrolyte and Cell Experimentation*	5.400	-
Congressional Add Subtotals for Project: EM4	9.000	-
Congressional Add Totals for all Projects	9.000	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / *Electronics and Electronic Devices*	Project (Number/Name) EM4 / *Electric Component Technologies (CA)*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
EM4: *Electric Component Technologies (CA)*	-	9.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Electronic Component applied research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017
Congressional Add: Silicon Carbide (SiC) Research-Army Research Laboratory ***FY 2016 Accomplishments:*** Investigated advanced wide band gap device processing technology that utilizes current silicon process facilities to provide lower cost components. Researched high performance packaging with increased thermal performance to enable full performance operation of wide band gap devices. Evaluated performance advantages of wide band gap power devices when applied to current circuit designs.	3.600	-
Congressional Add: Advanced Intelligent Battery Eliminator / Lithium-ion Capacitor Material Research, Electrolyte and Cell Experimentation ***FY 2016 Accomplishments:*** blank	5.400	-
Congressional Adds Subtotals	9.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / *Electronics and Electronic Devices*	Project (Number/Name) EM8 / *High Power And Energy Component Technology*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
EM8: *High Power And Energy Component Technology*	-	11.673	11.416	10.632	-	10.632	14.263	14.873	15.653	15.943	-	-

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 and Soldier 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).

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 on this Project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: High Power and Energy Technologies	1.187	-	-
Description: Research and evaluate electronic materials, structures, and components that will enable the realization of higher energy density and efficiency required by future Army systems such as electromagnetic armor, directed energy weapons, power grid protection, and other pulsed-power systems. Special emphasis is on components operating at high voltages - greater than (>) 10 kilovolts (kV).			
FY 2016 Accomplishments:			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** EM8 / *High Power And Energy Component Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Validated a 20 kV device and packaging concept; continued to extend the voltage and current capabilities of power switching components through modeling and research of the materials and fabrication processes; and researched materials and device technologies required to understand device operation at 40 kV for use in advanced Directed Energy systems and other Lethality and Survivability applications.			
Title: Advanced Solid-State Laser Technology and RF Photonics for Broadband Signal Processing ***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 (radio frequency) signals. Applied laser research will be conducted in close collaboration with domestic and foreign material vendors, university researchers, and major laser diode manufacturers ***FY 2016 Accomplishments:*** Explored novel fiber designs to increase power while preserving high beam quality for enabling laser directed energy weapons; and investigated power scaling of continuous wave (CW) and pulsed mid-wave infrared (IR) sources for IR countermeasure (IRCM) applications as well as pulsed eye-safe lasers for scanning Laser Development (LADAR) application ***FY 2017 Plans:*** Will investigate bulk solid-state and fiber laser materials and architectures for power scaling with the high beam quality required for directed energy, targeting, and IRCM applications; and design and develop RF photonic optical signal processing capabilities which will enable the near instantaneous, high resolution spectral analysis of broadband RF signal pulses with bandwidths up to 75 GHz. ***FY 2018 Plans:*** Will investigate innovative glass fiber laser architectures and bulk solid state laser materials and designs best suited for high energy per pulse operation with emphasis on low size, weight and power (SWAP) for applications including track illuminator lasers for DEW, Joule-class pulsed in-band Mid-Infrared sources for imaging sensor defeat, and Light Wave Infrared (LWIR) illuminators for operation in degraded visual environments; and will develop structures, devices, and architectures to enable optical phased arrays capable of handling high peak power transmission and low loss reception.	1.922	2.000	2.006
Title: Directed Energy (DE) /Electronic Attack Technologies/Spectrum Sensing and Exploitation ***Description:*** This effort investigates and evaluates 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	2.234	2.346	2.456

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** EM8 / *High Power And Energy Component Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
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 2016 Accomplishments:*** Designed EP device technologies for Next Generation Radar requirements by examining the adaptive RF technology threat against Army radar performance. ***FY 2017 Plans:*** Will apply EW device forensic concepts, methodologies, and techniques to Army Counter Unmanned Aerial System (CUAS) mission applications; and study the effects of RF energy against various unmanned aerial vehicle (UAV) targets in order to develop neutralization techniques that can be incorporated into existing and emerging EW systems. ***FY 2018 Plans:*** Will develop multi-device waveform packages for CUAS EA applications; will explore distributed low-cost ES sensors and applications to enhance situational awareness and enable novel and precise EA capabilities; will investigate next-generation radar EP performance in a complex electromagnetic environment; will develop a cognitive spectrum sensing test-bed with advanced signal processing algorithms to support EP and RF spectrum exploitation objectives such as cognitive radar; and will design and develop a full array of Cyber Electromagnetic Activities (CEMA) to investigate and validate the impact on developmental technologies and systems.			
Title: Electronic Components and Materials Research ***Description:*** Investigate and evaluate 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 2016 Accomplishments:*** Evaluated and designed reliability models of current and next generation wide band-gap semiconductor electronic components for device enhancements; determined advanced control and diagnostic methods for power switches to improve fault tolerance and efficiency; and validated concept for high voltage, high performance devices for operations above 20kV. ***FY 2017 Plans:*** Will evaluate the relationship between material quality and growth processes on electronic properties in Gallium Nitrade (GaN)-based wide-bandgap materials; investigate available GaN power device architectures and material systems for improving	3.109	3.464	2.993

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** EM8 / *High Power And Energy Component Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
reliability of electronic switching devices; and validate physics-based models of high-voltage power devices to enable improved performance and understanding of device operation. ***FY 2018 Plans:*** Will investigate ultra-wide band-gap power devices, architectures, and materials for power switching and distribution; will modify and validate high voltage physics-based model to support GaN based devices to provide better understanding of device operation and physics for improved reliability and performance; will conduct analysis of motor operation at high frequency or high voltage to determine feasibility of high torque, low revolutions per minute (RPM) motors; will investigate high frequency circuit topologies and, through modeling and component analysis, evaluate reliability and performance of circuit designs; will investigate designs, materials, and additive manufacturing processes that enable low cost, high performance power device packaging; will research AlGaN (aluminum GaN) material properties leading to the growth of high speed transistors and diode devices; and will explore AlGaN structures by varying substrate and epitaxial growth conditions.			
Title: Power System Components Integration and Control Research ***Description:*** Research and evaluate 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. ***FY 2016 Accomplishments:*** Researched and validated a universal power conversion concept that converts any input power to any output power for vehicle and micro-grid power applications; investigated controls for Tactical Energy Network control and prediction techniques, allowing any power input to feed any output power specification; designed distributed control and storage models to demonstrate more reliable and failure tolerant grids; and investigated, through modeling and analysis, the use of direct current and hybrid grid based technologies for the Army Tactical Energy Network. ***FY 2017 Plans:*** Will design electric- and magnetic-field sensors and processing algorithms to monitor micro-grid power; characterize power system components and support self-aware energy network architectures; validate distributed models and control algorithms enabling fault tolerance in Army energy networks; evaluate models of novel, distributed control and storage methods to improve energy efficiency of Army tactical energy networks; and investigate concepts for significantly reducing the volume of high-voltage power conditioning circuits, thereby enabling use in a projectiles and other compact lethality and protection systems. ***FY 2018 Plans:*** Will investigate control methods and components that enable reconfigurable power conversion based on varying voltage to reduce the size, weight, and power of conductors in constrained applications; will investigate concepts for compact and efficient high voltage power distribution topologies and control methodologies for continuous power applications; will analyze and model	3.221	3.606	3.177

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** EM8 / *High Power And Energy Component Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
concepts for significantly reducing the volume of high-voltage power conditioning circuits for use in projectiles and other compact lethality and protection systems; will develop designs and control methodologies for novel, low voltage alternating current (AC) and direct current (DC) distributed control and storage technologies to improve energy efficiency of Army tactical energy networks; will develop underpinning electric- and magnetic (E/H)-field technologies to support persistent power and energy monitoring of microgrid infrastructures and other systems; and will develop algorithms to robustly characterize E/H-field multi-scale events in complex noise environments.			
Accomplishments/Planned Programs Subtotals	11.673	11.416	10.632

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / *Electronics and Electronic Devices*	Project (Number/Name) H11 / *Tactical And Component Power Technology*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
H11: *Tactical And Component Power Technology*	-	11.353	8.714	8.332	-	8.332	7.652	7.850	8.048	8.215	-	-

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, decision making, and distribution across the battlefield. This Project also researches materials and components to develop lightweight, higher capacity, safer and more efficient power technologies that will enable self-sustainable, energy aware, continuous power generation while on the move and across battlefield environments.

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 in this Project is performed by the Army Research, Development and Engineering Command (RDECOM), Communications-Electronics Research, Development, and Engineering Center (CERDEC), Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Tactical Power Generation Technology	6.451	4.034	3.625
Description: This effort designs, investigates and validates Soldier-borne power generation and energy storage technologies in order to decrease Soldier load and power burden, 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 net zero capable Soldier. This effort will also investigate advanced hybrid battery chemistries for wearable, flexible battery designs.			
FY 2016 Accomplishments: Matured hybrid power sources to increase power and energy densities and reliability for high energy density devices; optimized electrolyte formulations and cathode materials to improve safety for higher energy and power solutions; researched existing and novel energy storage and power generation components to ensure their compatibility within the Soldier power grid; increased efficiency and optimized internal components of multi-fueled generator to facilitate development of a smaller, more portable device; investigated various wireless power transfer technologies and increased efficiencies to enhance power transmission distances; researched and designed interoperable devices capable of utilizing energy harvesting technologies to charge Soldier wearable hybrid power sources to achieve a net-zero energy posture; and investigated wireless solution for net-zero energy approach.			
FY 2017 Plans:			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H11 / *Tactical And Component Power Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will continue to investigate energy harvesting technologies and power generation components that produce usable power/energy for charging conformal batteries, mature internal component to facilitate a reliable power output, and conduct experiments on energy harvesting components to validate designs for increasing efficiency and power output; continue to investigate advanced lithium and hybrid battery chemistries for conformal battery designs; research novel energy storage chemistries, mature electrolyte and cathode materials to ensure safe, bullet tolerant conformal batteries, and mature components and formulations to safely increase power and energy densities to support extended missions. ***FY 2018 Plans:*** Will investigate and evaluate improvements to generator component technologies in energy harvesting devices for power conversion efficiency and enable more power generation on the move for near NetZero (produces as much energy as it uses) operations; investigate advanced lithium primary and rechargeable battery chemistries that are low cost and have the potential to double the runtime of current battery technology; conduct lab experiments on advanced battery cells configured with new chemistries, electrodes and electrolytes to validate the stability of the formulation and improvements in capacity; develop cell components to further improve the usable capacity within the ballistic battery to enable 20+ hours of continuous power; investigate fuel reformation techniques along with advanced materials to develop a small form factor, multi-fueled, wearable power source.			
Title: Energy Informed Operations ***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. Work in this effort complements Program Element (PE) 0603772A/Project 101. ***FY 2016 Accomplishments:*** Investigated new software and physical architectures to more efficiently distribute and manage power across the battlefield while reducing size and weight; developed predictive-analysis modeling software to enhance selection and employment of energy sources during the planning and execution mission phases, respectively; continued investigating techniques to reduce the energy demand of Soldier-worn peripherals; assessed draft standards for a centralized micro-grid approach and develop standards for a distributed micro-grid; designed a micro-grid architecture that distributes control to various power managers between the mission command system and smart power devices allowing for a mesh power network; continued research and design of smart power devices that can be monitored and controlled by the Commander, staff, or autonomously to prioritize loads, reduce fuel	4.902	4.680	4.707

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H11 / *Tactical And Component Power Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
consumption, and ensure reliable mission power; designed and fabricated improved renewable, alternative fuel, and high fuel-efficiency power sources to supplement base power and further reduce logistic footprint. ***FY 2017 Plans:*** Will draft interface specification for new software and physical architectures to more efficiently distribute and manage power across the battlefield; assess draft standards for distributed micro-grid; investigate additional approaches to distributed designs such as hierarchal design; continue research and design of smart power devices that can be monitored and controlled by the Commander, staff, or autonomously to prioritize loads, reduce fuel consumption, and ensure reliable mission power; investigate novel distribution (wireless) technologies to reduced power loss or ease set up burden in power distribution systems. ***FY 2018 Plans:*** Will simulate power micro-grid architecture, standards and interface specification for controller software and expand and update interface specification for software and physical architecture design to more efficiently distribute and manage power across the battlefield based on results of simulation; explore a domain-based approach for standards for distributed micro-grid; investigate performance and design of smart power generation and distribution devices such as generators, inverters, distribution boxes, energy storage and renewable energy systems, that can be managed, monitored and controlled by Soldiers or autonomously to prioritize load, reduce fuel consumption and ensure reliable mission power based on a distributed, rather than a centralized control approach; design architecture and software to incorporate wireless data technologies for the purpose of reducing power loss, complexity of setup and startup, and weight in power distribution systems; investigate the use of secure WiFi (wireless internet) and power line carrier methods to transmit control and status signals; analyze novel wireless power transmission technologies such as far field (for distances over 0.25 kilometers) power transfer based on microwave and laser power transmission technologies.			
Accomplishments/Planned Programs Subtotals	11.353	8.714	8.332

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / *Electronics and Electronic Devices*	Project (Number/Name) H17 / *Flexible Display Center*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
H17: *Flexible Display Center*	-	1.091	2.356	2.143	-	2.143	1.200	0.752	0.301	0.313	-	-

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 flexible electronics to incorporate the integration of electronic components, power systems, and sensors into three-dimensional flexible architectures. The research includes electronic modeling, design, fabrication, experimentation 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 Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas.

Work in this project is executed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Flexible Electronics Development (previously Flexible Display Center (FDC) and Flexible Electronics Development)	1.091	2.356	2.143
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 three-dimensional (3D) architectures. ***FY 2016 Accomplishments:*** Designed flexible hybrid electronic systems integrating traditional silicon electronics, sensors, and power. The applications included flexible sensing systems with components mounted on two-dimensional flexible substrates and integrated into three-dimensional structures for Soldier and small platform applications. ***FY 2017 Plans:*** Will design flexible hybrid electronic systems for human assessment, integrated three-dimensional support structures, and appropriate controls and sensor processing for health monitoring; and explore team or squad level resource optimization. ***FY 2018 Plans:*** Will investigate hybrid 3D printed sensors with integrated silicon (Si) complementary metal-oxide-semiconductor (CMOS) electronics; investigate co-design of algorithms, power distribution, and 3D printed sensors and electronics for extended duration monitoring of soldier's physiological and environmental state; examine and develop noise resistant and computationally efficient algorithms coupled to distributed sensing and computation hardware to enable real-time estimate of the human physiological state; investigate hardware, algorithms, and architectures to enable efficient, robust physiological monitoring of individuals within			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H17 / *Flexible Display Center*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
small, distributed groups; and will develop silicon-fiber based liquid metal inductors as well as develop and improve the fabrication process for stretchable gallium nitride (GaN) in silicon, which enables electronic monitoring of Soldiers performance on or close the skin without discomfort.			
Accomplishments/Planned Programs Subtotals	1.091	2.356	2.143

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / *Electronics and Electronic Devices*	Project (Number/Name) H94 / *Elec & Electronic Dev*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
H94: *Elec & Electronic Dev*	-	29.537	33.836	37.245	-	37.245	36.665	37.870	39.422	40.492	-	-

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), PE 0603008A (Command, Control, Communications Advanced Technology), PE 0603313A (Missile and Rocket Advanced Technology) and PE 0603772A (Advanced Tactical Computer Science and Sensor Technology).

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

Work in this Project is performed by the Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Antennas, Microwave Components, and Millimeter Wave Imaging (formerly Antennas and Millimeter Wave Imaging)	8.193	0.657	5.733
Description: This effort designs, characterizes, and validates high performance antenna, 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.			
FY 2016 Accomplishments: Devised and characterized carbon nanotube antennas woven into the fabric of the soldier's uniform; and performed in-situ simulation of printed antenna designs and low-profile metaferrite antenna designs.			
FY 2017 Plans: Will design and develop low profile apertures which meet future low-visibility signature requirements while maintaining RF performance; use advanced modeling to characterize electromagnetic performance of antennas and RF devices for Army			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H94 / *Elec & Electronic Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
applications; exploit the latest developments in engineered metamaterials with high permeability as the enabling technology for low-profile antennas; create antennas suitable for dismounted operations using carbon nanotube technology; develop antenna array designs using phase-change materials as the enabling technology to allow high performance beam steering; and develop specialized antenna designs for human health monitoring suitable for use by dismounted soldiers actively engaged in tactical operations. ***FY 2018 Plans:*** Will develop an analytical methodology that will define key electrical parameters for antenna optimization; will use this methodology to define electrical parameters in computer simulations; will develop experimental antennas exploiting previous materials development work at ARL; will investigate devices and materials for two-dimensional steering of millimeter-wave radar beams for applications such as helicopter collision avoidance in degraded visual environments; will design, fabricate, and characterize gallium nitride (GaN)-based integrated circuits for multi-mode radar applications; will examine techniques to achieve compact, linear RF front-end components to increase radar range and sensitivity; will mature RF micro-electromechanical system (MEMS)-enabled electronics for cognitive and adaptable radio and electronic warfare systems; and will investigate small, low-power sensors and control systems for use by soldiers and in unmanned applications.			
Title: Advanced Micro and Nano Devices ***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. Work being accomplished under PE 0601102A / Project H47 (Applied Physics Research) complements this effort. ***FY 2016 Accomplishments:*** Designed and characterized MEMS components for cognitive RF systems, low power Global Positioning Systems (GPS), and sensor technologies for improved Position, Navigation and Timing (PNT); designed and developed hardware and algorithms for distributed sensing, micro-autonomous system control and chip-scale integration of energetic nanoporous silicon for fuze initiation; characterized digital circuits on flexible stacked 2-dimensional (2D) electronic materials (e.g. graphene, molybdenum disulphide, boron nitride); and explored and optimized the RF performance of stacked 2D electronic materials. ***FY 2017 Plans:*** Will develop, integrate, and characterize RF MEMS components (e.g., filters, tunable passives and switches) for cognitive and adaptable radio and electronic warfare systems; continue development of a MEMS quad mass gyroscope with integrated active materials and sensor methods for assured PNT; design, analyze and formulate 2D material device structures for high frequency and low power analog RF and digital electronics; validate chip-scaled integration of energetic nanoporous silicon for device	2.080	2.155	1.947

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H94 / *Elec & Electronic Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
protection and fuze initiation; and integrate and characterize size, weight, power, and processing-constrained electronics, MEMS, and control algorithms for micro-autonomous systems, smart munitions, and soldier cognitive systems. ***FY 2018 Plans:*** Will explore 2D stacked electronic materials and tunable electronic properties for multifunctional integrated RF circuits; will mature piezoelectric-enabled RF MEMS components for cognitive and adaptable radio and electronic warfare systems; and will investigate integration of on-chip energetic materials for low-cost electronic device protection.			
Title: Security and Survivability for Wireless Tactical Networks (formerly Millimeter Wave and Microwave Components and Architectures for Advanced Electronic Systems) ***Description:*** This effort researches, designs and implements protocols and algorithms for networks of physical devices and autonomous systems operating under severe energy and bandwidth constraints, and which are vulnerable to adversarial infiltration. The objective is to enhance the performance and survivability of these tactical wireless networks through improved monitoring and detection of network problems, resulting from both adversarial activity and the operating environment, and through proactive adaption of the computer and network routers to these dynamics. ***FY 2016 Accomplishments:*** Investigated trade space for device and circuit performance requirements for application to future radar and sensing systems; correlated trade space results with emerging needs from communication systems to enable multiple-function hardware as RF frequency-performance requirements converge. ***FY 2017 Plans:*** Will investigate non-linear and linear RF architectures for advanced sensing applications; develop thermal models for III-V semiconductor devices enabling operations at multiple millimeter-wave bands; explore tunable and adaptive RF circuit topologies to enhance performance over conventional broadband circuit designs; design, model, and characterize circuits capable of supporting multiple bands while maintaining high power-added efficiency and output linearity; fabricate device and chip-level devices to validate improved RF capability in output power, efficiency, and bandwidth; develop miniature acoustic particle velocity sensors for battlefield threat awareness; develop MEMS-scale electric- and magnetic-field sensors to attach to power-lines for reconnaissance and surveillance applications; establish techniques to quantify protocols; generate secure networking protocols for deployment on resource-constrained devices and wireless/wired networks; and improve situational awareness through event and data reasoning via machine learning and statistical methods. ***FY 2018 Plans:***	0.369	5.617	1.567

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H94 / *Elec & Electronic Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will investigate and implement scheduling algorithms that dynamically adapt based on local- and network-wide conditions; will investigate network capacity improvement techniques; and will develop machine learning approaches for detecting, characterizing, diagnosing, and defeating potentially malicious activities in networks of physical devices and autonomous systems.			
Title: Vision Protection (formerly Imaging Laser Radar (LADAR) and Vision Protection) ***Description:*** This effort develops and characterizes materials for passive protection of electro-optic (EO) vision systems from lasers. ***FY 2016 Accomplishments:*** Researched active EO shutter systems that do not need a focal plane to activate and explored their implementation in Army optical systems; explored magneto-optic materials for use in protecting IR systems; investigated LADAR concepts for ultra-light or large UAV navigation; and studied novel and advanced optical science concepts, such as computational imaging and holography for enhanced imaging and sensing applications. ***FY 2017 Plans:*** Will extend the potential of EO techniques for the protection of shortwave-infrared (SWIR) detector and imaging systems against laser threats; and research and improve large-area EO shutters for simplified protection of optical systems on Army platforms. ***FY 2018 Plans:*** Will deposit EO material for protection on substrates with very high thermal conductivity to provide improved temperature control and reduced power consumption in fast EO shutter devices; and will optimize active protection concepts in the infrared (IR) for improved speed and threat laser wavelength rejection.	2.194	2.780	2.914
Title: Hazardous Material Detection (formerly Photonics and Opto-Electronic devices) ***Description:*** This effort investigates and characterizes novel sensor components and architectures to enable detection of hazardous substances for enhanced Soldier situational awareness and survivability. ***FY 2016 Accomplishments:*** Conducted spectral analysis investigations of candidate spectroscopic detection technologies to include femtosecond Coherent Anti-Stokes Raman Scattering and infrared photothermal spectroscopy; studied functional biomaterials in austere environments including the effect of temperature and other degradation pathways; and studied and modeled biological materials designed with specific functionality and stability for their interaction and affinity with non-biological materials such as metals. ***FY 2017 Plans:*** Will develop capability to integrate biological materials into biological assays and sensor systems and evaluate performance after thermal exposure to simulated harsh unconditioned storage conditions; and extend peptide material discovery to develop	0.950	1.910	1.957

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H94 / *Elec & Electronic Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
bio-hybrid materials which incorporate benefits of biological and synthetic materials for advantages such as self-assembly and self-healing and environmental response materials. Will investigate fiber-based collinear Multiplex Coherent Anti-Raman Spectroscopy (M-CARS) as a viable technique for explosives detection in liquid and solid samples; will characterize sensor components using different technical approaches, including magnetic and electromagnetic induction, to detect buried explosive devices; and investigate sensor node components that enable local data processing on the sensor node, communications between nodes in a sensor network, and distributed sensor information fusion. ***FY 2018 Plans:*** Will evaluate, characterize, and model mechanisms in semiconductor materials that can reduce thermal noise in IR devices and allow them to operate at higher temperatures, reducing the need for cryogenic cooling; will model and simulate to improve IR system-level performance; will model and develop energy efficient, compact semiconductor ultraviolet (UV) laser sources and detectors for short-range, non-line-of-sight communications; and will develop interfaces to connect biochemical signal detection with on-chip photonics and electronics for improved detectors.			
Title: Power and Thermal Management for Small Systems	3.299	2.026	0.891
Description: This effort investigates, designs, and fabricates MEMS-based components to improve power generation and micro-cooling technology for both dismounted Soldier and future force applications. ***FY 2016 Accomplishments:*** Implemented techniques for thermal interface measurements to characterize heat transfer in novel materials; developed compact 3-Dimensional (3D) integration techniques for power electronic devices; investigated novel methods for improving condensation heat transfer through acoustic excitation and surface enhancement; investigated integration of phase change materials into electronic packages for temperature spike suppression; investigated improved micro-fabrication techniques for microscale power devices to be used in power supply systems; investigated wireless energy conversion techniques for powering wearable and portable devices; developed fabrication processes for stretchable, wearable, and light-weight power components; investigated thermoelectric, pyroelectric, and thermo-photovoltaic power generation techniques and materials for applicability in direct power generation; and characterized advanced materials for improved fuel conversion efficiency and apply them toward developing improved reaction models. ***FY 2017 Plans:*** Will use new thermal interface measurement techniques to identify interface properties for optimizing heat transfer in new materials systems; implement methods for improving condensation heat transfer using acoustic excitation and surface enhancement; optimize micro-fabrication techniques for micro-scale power devices for compact power sources and conversion; experimentally validate stretchable, wearable, light-weight power components integrated into fabric; identify optimum phase change materials for temperature spike suppression in electronic packages; implement superlattice thermoelectric materials, thin-			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H94 / *Elec & Electronic Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
film pyroelectrics, and multi-fuel thermophotovoltaic devices for direct power generation; and optimize reaction models and apply them towards the development of micro-combustion applications with improved fuel conversion efficiencies. ***FY 2018 Plans:*** Will improve the size, weight, and packaging of electronics with higher thermal handling characteristics; and will utilize excess heat through thermal-to-electric conversion for more energy efficient electronics via new materials, device technologies and structures, as well as the use of novel physical phenomena.			
Title: Emerging Electronic Devices and Circuits ***Description:*** This effort investigates and characterizes emerging electronics such as analog, mixed signal, and millimeter wave. Efforts entail design, fabrication, and analysis of electronic devices and integrated circuits for use in extreme environments necessary for Army applications. ***FY 2016 Accomplishments:*** Explored emerging materials, components, and circuits that enable low energy and power efficient RF devices; designed novel integrated circuits that provide improvements in power efficiencies, linearity, and noise; and explored system/chip constraints for ultra-linear performance to enable Soldier-level communication in contested RF environments.	1.644	-	-
Title: Advanced Infrared Technology (forermly Infrared (IR) Imaging) ***Description:*** This effort designs and characterizes materials, components, and focal plane arrays (FPAs) for the next generation of night vision systems, missile seekers, and general surveillance devices. Materials and devices investigated include mercury cadmium telluride (MCT) and resonant quantum well infrared photodetector (R-QWIP) arrays for both the mid-wave infrared (MWIR) and long-wave infrared (LWIR) spectral regions with goals to increase the operating temperature and decrease the cost of FPAs. Additionally, modeling of infrared device performance, at both the device and system levels, is being performed for all major infrared systems (MCT, R-QWIP, Indium antimonide (InSb), and strained layer superlattices) of importance to the community. ***FY 2016 Accomplishments:*** Investigated extremely low-doped MCT IR material grown on domestically available lattice matched substrates for different spectral regions, including SWIR and LWIR applications; studied effects of thermal cycle annealing on MCT material as it pertains to dopant species and profiles; studied the implementation of resonant features on MCT for higher temperature operation; and characterized and analyzed R-QWIP material and devices for improved quantum efficiency and operating temperature. ***FY 2017 Plans:*** Will characterize and analyze broadband and two-color (LWIR/LWIR and LWIR/VLWIR) R (Resonant)-QWIP and resonant strained layer superlattice arrays for hyperspectral and other Army applications; investigate resonant MCT structures for LWIR imaging at higher operating temperatures than is currently available; expand device modeling capabilities to three dimensions	2.194	1.695	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H94 / *Elec & Electronic Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
to garner a better understanding of the interplay between photon absorption, charge drift and diffusion, and passivation with the choice of device architecture (mesa or planar) and material parameters; and develop a process for passivation of MCT IR arrays using cadmium telluride atomic layer deposition for maximal conformal coverage.			
Title: Power and Energy ***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. The research accomplished under PE 0601104A/Project VS2 (multi-scale modeling) complements this effort. ***FY 2016 Accomplishments:*** Characterized and transitioned 5-volt lithium ion battery electrodes and electrolytes for development of a sample cell for laboratory testing and assessment; investigated novel battery chemistries for Soldier power; characterized new alkaline membranes for fuel cell applications; developed lower cost catalysts for alkaline fuel cells; developed regenerable sulfur sorbents for desulfurization of JP8 at temperatures of 300-400 degrees C; and determined degradation mechanisms and lifetimes of sulfur-tolerant palladium alloys for hydrogen separation from JP8 reformate for use in fuel cells. ***FY 2017 Plans:*** Will characterize aqueous lithium ion surface electrode interface mechanisms to develop safe, novel, aqueous battery chemistries; fabricate bipolar membrane materials and membrane electrode assemblies for reduced size, weight and complexity of compact fuel cells; investigate effects of 3D anode/cathode electrolyte cell structures versus conventional structures in lithium ion batteries; further improve regeneration of sulfur-sorbent materials for room temperature JP8 fuel desulfurization; and perform spectroscopic analysis of hydrogen separation in palladium alloys to establish JP8 reformate reaction mechanism. ***FY 2018 Plans:*** Will investigate the deactivation mechanism of hydrocarbon combustion catalysts through in-situ studies with advanced spectroscopy and electron microscopy and develop strategies to design highly active and durable catalyst materials for compact power generation; will develop improved electrolytes for high voltage storage chemistries; will optimize development of high voltage electrolytes, additives and cathodes for energy density and safety; will improve rise time and duration of thermal batteries within size, weight and power (SWAP) constraints; and will develop an acid-alkali fuel cell membrane electrode assembly.	3.882	2.837	2.783
Title: Sensor Protection Technologies	2.444	-	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H94 / *Elec & Electronic Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Description: This research will develop technologies to specifically address laser threats at different frequencies (e.g. ultraviolet, infrared) and at a variety of pulse widths (continuous wave (CW), nanosecond, femtosecond). This research will develop technologies to protect Army radars by agile spectrum exploitation, reconfigurable high speed switching technology, and novel RF power limiters and switching devices to protect RF front-ends (RFFEs) in contested environments as well as from self-interference challenges where multiple RF systems are operating in close proximity. ***FY 2016 Accomplishments:*** Studied new materials and devices to counter the laser threat against sensors, particularly the threat of wavelength-agile lasers as threats evolve toward directed high energy weapons and ultrafast femtosecond pulsed lasers, to include short-wavelength infrared and MWIR sensor protection; investigated new techniques for protection against continuous-wave (CW) high energy laser threats; and characterized materials as optical limiters against femtosecond pulsed laser threats across a variety of wavelengths (visible through MWIR).			
Title: Energy Harvesting	2.288	2.524	2.764
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 2016 Accomplishments:*** Studied the properties of bandgap engineered indium gallium nitride and highly mismatched alloys to develop the capability to split water to produce hydrogen to use for fuel or as intermediates for fuel; characterized thermoelectric and pyroelectric material properties for energy harvesting; investigated and characterized properties of ultra-energetic (isotopic/isomeric) materials and matched energy conversion structures as a long endurance energy source; and refined growth parameters for novel photoelectric materials for use with non-solar applications. ***FY 2017 Plans:*** Will characterize electrical and optical performance of bandgap-engineered gallium nitride for water splitting for hydrogen-derived fuel intermediaries; develop improved, thin-film pyroelectric and thermal materials and packaging for high-rate thermal cycling; investigate properties of ultra-energetic (e.g., isotopic/isomeric) materials for enhanced energy and/or gamma release mechanisms; develop photovoltaic devices with surface nanostructures for broad-angle, anti-reflection and light-trapping			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H94 / *Elec & Electronic Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
capabilities to improve power generation; and investigate integration of novel, stretchable, passive electronics for Soldier energy harvesting applications and wireless energy transfer. ***FY 2018 Plans:*** Will develop photo-corrosion mitigation strategies that will enable stable photo-electrolysis to produce hydrogen gas; will develop catalysis process for faster electron transfer, create engineered polarization in gallium nitride devices, develop highly mismatched alloy material with good electronic and optical properties for water molecule splitting; will develop spectral emission/transmission with spectrally tailored bandgap cells to increase far-field thermo-photovoltaic conversion efficiency; and will develop polariton modes between emitter and cell to increase conversion efficiency and power density. Will develop photo-corrosion mitigation strategies that will enable stable photo-electrolysis to produce hydrogen gas; develop catalysis process for faster electron transfer, create engineered polarization in gallium nitride devices, develop highly mismatched alloy material with good electronic and optical properties for water molecule splitting; develop spectral emission/transmission with spectrally tailored bandgap cells to increase far-field thermo-photovoltaic conversion efficiency; and will develop polariton modes between emitter and cell to increase conversion efficiency and power density.			
Title: Energy Efficient Electronics & Photonics (formerly Energy Efficient Electronics) ***Description:*** This effort addresses sustainment operations by unburdening the Soldier and reducing logistics requirements (e.g., fewer batteries) for communications, computing, and sensing. The objective is to improve the underlying energy efficiency of supply and demand for soldier-portable and unattended sensor electronics to enable the dismounted Soldier to maintain communications, freedom of movement, and increase mission duration. The majority of the electronics power used by the dismounted soldier and by unattended sensors is attributable to RF communications. In addition, freedom of movement and action during sustained and high tempo operations requires seamless battery recharging. To address these challenges, energy efficient electronics research includes RF circuits, devices, materials and wireless power distribution. Energy efficiency improvements will be developed and investigated in support of five key sensor and electronic areas: RF component devices, passively powered components, low-power, long-lived sources, wireless power transfer, and advanced battery chemistries. Additionally, materials and devices used for photonic applications, such as laser diodes and fiber lasers, will be studied and improved with an emphasis on overall size, weight, and power consumption efficiency gains. ***FY 2017 Plans:*** Will measure and characterize performance of heterogeneous materials integrated into radio frequency front-end components (e.g., amplifiers, filters, and switches); design and simulate performance of realistic waveforms on ultra-low power field-programmable gate arrays (FPGA) and accelerator cores; develop an analog integrated circuit characterization capability; explore extramural prospects for low-power RF transceiver design techniques using leading node (analog) device technologies; and	-	5.023	5.538

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H94 / *Elec & Electronic Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
characterize passive voltage amplification with MEMS piezo-transformers and multi-layer copper air-core designs, efficient power management of isotopic power sources, and improved coupling in wireless transmission. ***FY 2018 Plans:*** Will explore heterogeneous integration of efficient III-V and II-VI semiconductor devices with leading edge process technology to enable small form-factor, highly linear RF circuits; will examine digital back-end accelerators for implementing realistic communication waveforms at substantially reduced power; will explore energy efficiency improvements by utilizing sub-threshold RF front-ends and high efficiency and high linearity analog components; will investigate vertical and lateral carrier transport in semiconductor laser diode structures towards the realization of large area UV emitters; will investigate the use of water-in-salt electrolytes to increase voltage window of supercapacitors and Li ion batteries and investigate the use of LiS in aqueous electrolytes for improved safety and improved energy storage; will increase coulombic efficiency of dual intercalation electrodes for inexpensive grid energy storage; will investigate additives to limit dendrite formation of Li metal batteries for high energy density rechargeable batteries; will investigate solid-state chemistries for safe Li batteries; will investigate enhanced acoustically-coupled inductive wireless power transfer; will reduce circuit power consumption through the design and fabrication of passively powered ambient sensors that enable zero power sleep mode for electronics; and will develop extremely low power, intelligent power management for low power, long-life electronics.			
Title: Precision Measurement Technology for Contested Environments (Technologies for Anti Access / Area Denial) ***Description:*** This research focuses on technologies that will enable precise and assured position, navigation and timing in 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, fabrication, and testing 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. ***FY 2017 Plans:*** Will design and fabricate a MEMS quad mass gyroscope (QMG) to improve MEMS gyro performance to less than 1 degree-per hour bias instability; design and fabricate a vacuum packaging solution for a MEMS QMG that will achieve an in-package pressure a million times less than atmospheric pressure; investigate and analyze Optoelectronic oscillators (OEOs) and laser frequency comb architectures and the direct synchronization of an atomic cell signal to an OEO in order to create an ultra-stable local oscillator source that could increase the period of desired accuracy of military geolocation systems that require GPS synchronization from less than 1 minute to more than 1 hour; identify and develop techniques to suppress noise induced in a	-	2.512	2.941

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H94 / *Elec & Electronic Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
transmission media, such as free-space, air, or optical fiber, by transmission of frequency signals via lasers to maintain frequency stability ten times better than GPS; and explore more compact anti-jam GPS and body-worn, textile-integrated antenna designs to support future pseudolite and dismounted Soldier navigation. ***FY 2018 Plans:*** Will characterize and analyze the residual frequency instability of a free-space, laser-based frequency transfer system that could be used to synchronize the Army's PNT devices in the absence of signals from GPS; will mitigate environmentally induced noise sources to increase the timing stability on optical-electronic devices used for precision timing; will investigate and develop MEMS inertial sensors, aiding sensors, and sensor fusion approaches to enable navigation-grade inertial measurement units for assured PNT; will conduct simulations and explore development of a new technique for anti-jam GPS antennas distributed on the human body; will develop methods for night-time three-dimensional reconstruction using thermal imagery for autonomous navigation and detection of medium to low emissivity surfaces (e.g., metals) at night to assist warfighters in locating manmade targets; will develop methods for real-time vegetation and land classification for aiding position/locality determination.			
Title: Anti-Tamper (AT) Technology Development ***Description:*** This effort develops tools, devices, and techniques to protect acquisition program systems and Critical Program Information (CPI) from adversarial threats. This work is executed by the Army Anti-Tamper Office located at the Aviation and Missile Research, Development and Engineering Center (AMRDEC) at Redstone Arsenal, AL. ***FY 2017 Plans:*** Will begin development of AT tools and techniques for commercial microelectronics, architecture-level AT technologies, threat-based sensors, and secure processor Intellectual Property (IP). ***FY 2018 Plans:*** Will mature AT tools, techniques and IP for projects Rigor 1 and Rigor 1a; will complete design of architecture-level AT integration technologies; will continue development of threat-based sensors and secure processor Intellectual Property (IP); will finalize contractual scope and tape-out for production of test parts from Trusted Foundry; and will receive and begin laboratory testing of Rigor devices.	-	4.100	5.025
Title: Cognitive Countermeasures Technology Development ***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. ***FY 2018 Plans:***	-	-	2.010

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H94 / *Elec & Electronic Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will design, model, and characterize advanced laser materials and architectures with low size, weight, power and cost to improve laser output power for aircraft survivability applications. Will explore potential for radio frequency technologies to enable early warning threat detection.			
Title: Technologies for Alternative Energy: ***Description:*** Design and develop novel concepts of energy generation, energy capture materials, and component technologies for efficient conversion of ambient energy to electrical energy for use and storage. Design components to include microscale power devices for multimodal harvesting and efficient distributed power conversion. ***FY 2018 Plans:*** Will investigate catalyzing carbon dioxide (CO2) to longer chain hydrocarbons for energy storage; will design a photo-electrochemical cell for studying CO2 conversion to a fuel; will develop cost effective energy storage solutions for microgrid applications to enable renewable resource integration; and will develop advanced concepts that lead to the development of nanophotonic components for energy harvesting and optimization of hybrid nanostructured materials for more efficient solar energy conversion.	-	-	1.175
Accomplishments/Planned Programs Subtotals	29.537	33.836	37.245

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602709A *I Night Vision Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	37.501	36.079	34.723	-	34.723	35.005	36.267	37.536	38.823	-	-
H95: *Night Vision And Electro-Optic Technology*	-	32.501	36.079	34.723	-	34.723	35.005	36.267	37.536	38.823	-	-
K90: *NIGHT VISION COMPONENT TECHNOLOGY (CA)*	-	5.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

This Program Element (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, and maintain a higher degree of situational understanding (SU). Project H95 advances infrared (IR) sensor technologies, assesses and evaluates 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.

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 060708045 (End Item Industrial Preparedness Activities).

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 in this PE is performed by the United States (U.S.) Army Communications-Electronics Research, Development and Engineering Center (CERDEC)/Night Vision and Electronic Sensors Directorate (NVESD), Fort Belvoir, VA.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army	Date: May 2017
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602709A *I Night Vision Technology*

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	38.807	36.079	37.081	-	37.081
Current President's Budget	37.501	36.079	34.723	-	34.723
Total Adjustments	-1.306	0.000	-2.358	-	-2.358
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.306	-			
• Adjustments to Budget Years	0.000	0.000	-2.505	-	-2.505
• Civ Pay Adjustments	0.000	0.000	0.147	-	0.147

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2016	FY 2017
Project: K90: *NIGHT VISION COMPONENT TECHNOLOGY (CA)*		
Congressional Add: *Program Increase*	5.000	-
Congressional Add Subtotals for Project: K90	5.000	-
Congressional Add Totals for all Projects	5.000	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602709A / *Night Vision Technology*	Project (Number/Name) H95 / *Night Vision And Electro-Optic Technology*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
H95: *Night Vision And Electro-Optic Technology*	-	32.501	36.079	34.723	-	34.723	35.005	36.267	37.536	38.823	-	-

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) at an affordable price. Technologies include novel focal plane arrays (FPAs), lasers, processing, 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 Circuit (DROICs) to enable multifunction sensing. This Project also investigates and improves new semiconductor materials formed by a combination of elements from the periodic table. In addition, this Project develops algorithms for enhanced IR functionality, which provide 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 (SWaP) is a key research objective for all efforts

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 in this Project is performed by the United States (US) Army Communications-Electronics Research, Development and Engineering Center (CERDEC)/Night Vision and Electronic Sensors Directorate (NVESD), Fort Belvoir, VA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Distributed Aided Target Recognition (AiTR) Evaluation Center of Excellence	1.725	2.486	2.586
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 AiTR algorithms are evaluated against realistic operational scenarios, to include roadside threats/explosively formed projectiles, in aided or fully autonomous RSTA missions.			
FY 2016 Accomplishments: Investigated inclusion of airborne countermine data in algorithmic correlation approaches to improve image based detection and confirmation; explored new algorithms to improve slew-to-cue and robotic move to a way-point for multifunction display capability; applied low power techniques and look-up libraries to improve signal processing and algorithms for threat detection and tracking			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*	**Project (Number/Name)** H95 / *Night Vision And Electro-Optic Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
to minimize power consumption; augmented current evaluation infrastructure and data repository used for RSTA and countermine applications to include human activity recognition. ***FY 2017 Plans:*** Will investigate holistic algorithms that address multiple targets, validate signatures and improve Probability of Detection/False Alarm Rate (Pd/FAR) rates; develop a baseline algorithms to provide a framework for cognitive image processing techniques that collect multiple types of data from networks and apply continuous learning techniques to adapt to evolving threats. ***FY 2018 Plans:*** Will investigate new algorithms for situational understanding and threat awareness in all environments through hostile fire detection and location and obstacle avoidance; validate framework for image processing techniques that ingest multiple types of data from networks to increase Pd/FAR rates on multiple targets; assess algorithm performance against realistic operational scenarios and validate correlation processing of multiple types of multispectral two-dimensional (2D) and three-dimensional (3D) data of multiple targets to increase Pd while reducing the FAR using a cognitive image processing frame work.			
Title: Sensor Modeling and Simulation Technology ***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, identification and assessment of phenomenology associated with imaging technologies, and calibration of imaging technologies. ***FY 2016 Accomplishments:*** Implemented and began verification and validation of a two dimensional version of sensor performance model and measurement techniques; extended model and measurement methodologies to incorporate non-linear processing to include image quality based metric and advanced image processing algorithms; researched modeling and simulation techniques for multi-function or multi-mission sensor systems; researched new techniques and implementation methods such as virtual prototyping to support evolution of the modeling and simulation tools development. ***FY 2017 Plans:*** Will research and develop improved imaging sensor performance metrics, using computational modeling and imaging system design and evaluation. The objectives are to extend model and measurement methodologies to assess non-linear image processing algorithms and metrics; investigate the most effective combination of computational modeling techniques, lab assessments, and field evaluations; extend confidence level calculations to non-linear systems; define verification and validation	5.021	5.246	5.110

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*	**Project (Number/Name)** H95 / *Night Vision And Electro-Optic Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
methodology for sensor data collections and human performance sensors; and research methods to advance full spectral image generation and processing into augmented reality and virtual representation of new sensor modalities. ***FY 2018 Plans:*** Will research, develop, and validate Electro-optic/Infrared (EO/IR) sensor performance models and simulations for computer-aided prototyping and augmented reality applications through field data collection, lab measurements, human signature exploitation, and algorithm development; research and develop robust and comprehensive measures of target acquisition performance; validate with lab measurements; leverage commercial gaming simulation technologies and augmented reality as a means to increase situational understanding.			
Title: Advanced Multifunction Laser Technology ***Description:*** This effort investigates technology for a new class of multi-wavelength laser modules which will have the ability to replace multiple laser targeting systems and reduce the 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. ***FY 2016 Accomplishments:*** Validated and matured multifunction Shortwave Infrared (SWIR) fiber-based laser breadboard, and components for performing functions such as laser range finder (LRF), laser illumination, laser pointing, and Light Detection and Ranging (LIDAR); investigated novel laser pulsing technologies to allow for compact and lightweight, solid state lasers at reduced cost; designed a fiber-based laser operating in an extended-SWIR spectral band for active imaging for covert conditions. ***FY 2017 Plans:*** Will investigate novel techniques for improving efficiency, pulse energy and size of MWIR and LWIR solid state lasers; investigate methods to convert laser operating frequencies from operations in shorter spectral wavebands into the MWIR and LWIR spectral wavebands for use in applications such as locating and neutralizing threat sensors, 3D imaging, and landing in degraded visual environments; determine methods for optimizing laser frequency; investigate novel approaches to optimize peak output powers and reduce size, weight and power consumption. ***FY 2018 Plans:*** Will conduct investigations of various MWIR laser configurations for threat sensor detection; validate and compare performance of different laser breadboards, including bulk solid state and fiber based pump lasers for frequency conversion, compare different	5.073	4.746	5.037

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*	**Project (Number/Name)** H95 / *Night Vision And Electro-Optic Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
frequency conversion techniques for efficient generation of MWIR; and perform trade studies of LWIR laser designs, and select best approach for implementation and further evaluation.			
Title: Advanced Structures for Cooled Infrared Sensors ***Description:*** This effort researches detector materials and substrates for IR sensors. This effort investigates and improves III-V materials (materials formed by a combination of elements from Groups III and V of the periodic table) and II-VI material (materials formed by a combination of elements from Groups II and VI of the periodic table), to provide low cost, large format, high quality imaging sensors. The emphasis is on reducing material defects and increasing reliability by developing new ways to prepare and treat the substrates, new designs, and new methods of growing the structures. The goal is to develop cost effective components for high definition Army IR sensors. ***FY 2016 Accomplishments:*** Investigated new growth methods, detector structures and pixel level wavelets for capturing photons and meta-materials into FPAs for improving the responsivity (signal to noise ratio) of SWIR through LWIR wavebands using III-V and II-VI materials; continued investigation of new techniques for etching and passivating LWIR III-V and II-VI small pixel structures; investigated small FPA pixel pitch interconnect technologies. ***FY 2017 Plans:*** Investigate in-house growth of new LWIR III-V semiconductor compound materials and device structures focusing on optimizing quantum efficiency and material lifetime; research methodologies to improve the signal-to -noise ratio and increase the sensitivity of small pixel III-V structures. Continue to investigate small-pitch pixel processing including mitigation of etch damage and novel interconnect techniques to enable larger-format focal planes with better resolution and increased range.	5.541	5.892	-
Title: Solid State Low Light Imaging ***Description:*** This effort develops true starlight and very low light sensing FPA technology, with reduced power and production cost, for Soldier vision enhancement in degraded visibility conditions. The objective of this effort is an all solid state IR sensor for replacement of current Image Intensifier (I2) vacuum tube technology that can be integrated with new 3D DROIC technology. ***FY 2016 Accomplishments:*** Leveraged complementary metal-oxide semiconductor (CMOS) and 3D DROIC design to achieve high resolution, low latency, stacked, lowlight silicon sensor and micro-display imaging components; validated design by conducting experiments of stacked wafer fabrication runs with CMOS pixel densities equivalent to the full resolution designs; investigated and designed low profile folded and switchable optics compatible with objective lens and eye piece lens functions suitable for the solid state stacked imager design.	4.781	-	-
Title: Three-Dimensional Micro-Electronics for Night Vision Sensors	5.683	5.836	6.076

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*	**Project (Number/Name)** H95 / *Night Vision And Electro-Optic Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Description: The goal of this effort is to investigate new, microelectronics, reconfigurable optics and display technologies to interface with emerging 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. ***FY 2016 Accomplishments:*** Investigated new lens designs to include radially indexed materials for enhanced beam steering, meta-materials, and improved coatings for improved transmission/reflectivity. Micro-display research will explore new organic light emitting diode (OLED) materials, which offer luminance and multi sensor input for sensor visualization with a 3D DROIC interface. ***FY 2017 Plans:*** Will perform downselect of new lens designs investigated in Fiscal Year (FY) 2016 and optimize technical approaches based on size, weight, power, performance, and cost metrics; determine feasibility of the reconfigurable and adaptive optics; characterize transmission, reflectance and absorption of materials and material coatings, and begin assessment of suitability for military environments; determine efficacy of micro-displays necessary for high brightness operation and demonstrate compatibility with multiple video source inputs. ***FY 2018 Plans:*** Will validate range performance of reconfigurable optical elements in sensor objectives and augmented reality display optics while maintaining optimized overlay of display and real scene; conduct investigation of suitability of novel optical element surface treatments for high optical throughput; mature high resolution displays for targeting and maneuver; validate optical components through bench top end-to-end testing.			
Title: Multi-Function Digital Readout Integrated Circuits for Cooled and Uncooled Focal Plane Arrays	4.677	6.645	6.334
Description: The objective of this effort is the development of advanced 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. ***FY 2016 Accomplishments:*** Investigated and developed novel Analog to Digital (A/D) architectures for new high definition FPAs; investigated A/D architectures compatible with 2D or 3D integration by use of advanced lithographic techniques; developed small pitch vertical interconnect			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*	**Project (Number/Name)** H95 / *Night Vision And Electro-Optic Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
technology such as Through-Silicon Via (TSV) technology, Isolated Deep Silicon Via Technology (iDSV), and wafer thinning and bonding processes to allow for 3D stacking of sensor display functionalities. ***FY 2017 Plans:*** Will conduct experiments to validate multi-layer ROIC functionality; explore novel material research and newly maturing technologies to increase on-chip processing capabilities; examine and quantify the ability of multi-layer ROIC technology to store large amounts of charge in very small pixel areas, while maintaining state-of-the-art noise performance; investigate the high dynamic range imaging capabilities enabled by multi-layer ROICs; begin designs of a digital ROIC circuit for uncooled sensors to enable increased performance. ***FY 2018 Plans:*** Will fabricate multi-layer ROIC to significantly increase ability to storage of charge in a very small pixel area; validate new ROICs and arrays with increased dynamic range capability over legacy cooled imaging sensors; refine designs of digital ROIC circuitry for uncooled sensors; produce initial test structures for laboratory validation of designs.			
Title: Computational Imaging ***Description:*** This effort develops component technology designed to increase battle space awareness, threat detection and target identification (ID) by using a methodology of computation algorithms and optics combined with display and vision processing . The objective is to provide extended range, multi-spectral imaging capability, with reductions to the size, weight and cost (SWaC), for the individual warfighter. This effort will leverage work accomplished under Multi-Function DROICs for Cooled and Uncooled FPAs to provide improved mounted and dismounted soldier situational understanding in urban and complex terrain under low light and visibility conditions. ***FY 2017 Plans:*** Will conduct a trade study focused of optics, sensors and processing focused on day/night helmet mounted 3D imagers; research and validate computational algorithms centered on high speed hemispherical threat detection and localization sensors and optics; explore applications of new optics concepts for multispectral weapon and handheld surveillance devices. ***FY 2018 Plans:*** Will investigate novel optics, sensors, and processing approaches for day/night visualization; conduct experiments in 3D scene visualization with compact infrared sensors; validate predicted algorithm performance for threat detection and sensor localization; begin development of new optic for performing real-time detection and localization operations	-	5.228	4.413
Title: High Sensitivity High Speed Uncooled Longwave Infrared (UCIR) Technology	-	-	5.167

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*	**Project (Number/Name)** H95 / *Night Vision And Electro-Optic Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Description: Develop 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, unmanned ground/air vehicles sensors, 360º situational awareness sensors, and missile seekers by leveraging commercial processes. ***FY 2018 Plans:*** Will conduct experiments on new materials and structure designs; produce initial test arrays based on the new materials; incorporate advances in DROIC designs to enable sensitivity and dynamic range increases over currently available uncooled LWIR technology.			
Accomplishments/Planned Programs Subtotals	32.501	36.079	34.723

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602709A / *Night Vision Technology*	Project (Number/Name) K90 / *NIGHT VISION COMPONENT TECHNOLOGY (CA)*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
K90: *NIGHT VISION COMPONENT TECHNOLOGY (CA)*	-	5.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

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 2016	FY 2017
Congressional Add: Program Increase	5.000	-
FY 2016 Accomplishments: This is a Congressional Interest Item.		
Congressional Adds Subtotals	5.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602712A / *Countermine Systems*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	35.586	26.497	26.190	-	26.190	25.111	29.692	30.234	30.851	-	-
H24: *Countermine Tech*	-	18.686	20.821	20.453	-	20.453	18.248	21.695	22.114	22.565	-	-
H35: *Camouflage & Counter-Recon Tech*	-	5.400	5.676	5.737	-	5.737	6.863	7.997	8.120	8.286	-	-
HB2: *COUNTERMINE COMPONENT TECHNOLOGY (CA)*	-	11.500	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

This Program Element (PE) investigates, designs, and evaluates 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; directed energy; 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 advances 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 evaluates 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 complements 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 Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Work in this PE is performed by the United States (U.S.) Army Research, Development and Engineering Command (RDECOM)/Communications-Electronics Research, Development and Engineering Center (CERDEC)/Night Vision and Electronic Sensors Directorate (NVESD), Fort Belvoir, VA.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army					Date: May 2017
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*			R-1 Program Element (Number/Name) PE 0602712A *I Countermine Systems*		
B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	36.568	26.497	26.663	-	26.663
Current President's Budget	35.586	26.497	26.190	-	26.190
Total Adjustments	-0.982	0.000	-0.473	-	-0.473
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.982	-			
• Adjustments to Budget Years	0.000	0.000	-0.500	-	-0.500
• Civ Pay Adjustments	0.000	0.000	0.027	-	0.027

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2016**	**FY 2017**
Project: HB2: *COUNTERMINE COMPONENT TECHNOLOGY (CA)*		
Congressional Add: *Program Increase*	11.500	-
Congressional Add Subtotals for Project: HB2	11.500	-
Congressional Add Totals for all Projects	11.500	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602712A / *Countermine Systems*	Project (Number/Name) H24 / *Countermine Tech*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
H24: *Countermine Tech*	-	18.686	20.821	20.453	-	20.453	18.248	21.695	22.114	22.565	-	-

A. Mission Description and Budget Item Justification

This Project investigates, designs and evaluates 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 Assistant 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 U.S. Army Communications-Electronics Research, Development and Engineering Center (CERDEC)/Night Vision and Electronic Sensors Directorate, Fort Belvoir, VA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Standoff Sensors for Explosive Hazard Detection	9.571	10.511	11.155
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			
FY 2016 Accomplishments: Validated dual band FL GPR components using new phased arrays; explored polarization phenomenologies with Short Wave Infrared (SWIR) through Long Wave Infrared (LWIR) waveband sensors to discriminate man-made objects; investigated vibration sensors to distinguish targets from clutter; explored ground profiling sensors (Light Detection and Ranging (LIDAR), X-band radar) to improve FL GPR data by removing surface clutter; studied new identification and confirmation sensors, such as autonomous Neutron Gamma sensors.			
FY 2017 Plans: Will continue the investigation of vibration sensing and polarization technologies for the discrimination of man-made objects; will continue the investigation of advanced processing techniques to combine FL GPR and FL vibration sensor data in order to reduce false alarm rates; will continue to investigate new sensors for identification and confirmation of threats; will investigate microwave			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602712A / *Countermine Systems*	**Project (Number/Name)** H24 / *Countermine Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
sensors, as well as digital receivers, for increased sensitivity of FL GPR sensors in order to help discriminate concealed explosive hazards on roadsides; will explore techniques to detect wires from standoff distances. ***FY 2018 Plans:*** Will explore and develop novel sensing methods using multiple geometric configurations to enhance FL sensor modalities, including multi-look GPR, LWIR and Visible; mature processing techniques by combining datasets from multiple sensor technologies in order to improve probability of detecting threats in complex environments; investigate new sensors for confirmation of threats for modular platforms; validate techniques to detect wires from standoff distances.			
Title: Chemically Specific Detection of Explosive Threats ***Description:*** This effort investigates emerging chemical explosive hazard detection technologies, including Home Made Explosives (HMEs), to address Warfighter needs. The effort will provide technologies for standoff detection and confirmation of emerging threats and production facilities, and it is complimentary to the work being accomplished under Program Element (PE) 0602622A/Project 552. ***FY 2016 Accomplishments:*** Analyzed data collected in various conditions, and optimized sensitivity and spectral selectivity of new polymer-based quantum dot sensors using remote and hand held excitation sources; investigated new technologies to extract surface vapor signals.	2.748	-	-
Title: Dismounted Explosive Hazard Detection Technology ***Description:*** This effort investigates emerging component technologies to enhance detection of explosive hazards, including metallic and non-metallic landmines, Improvised Explosive Devices (IEDs), 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. ***FY 2016 Accomplishments:*** Conducted data collections in relevant simulated environments to refine the best combination of novel components and sensors for real-time detection and identification of buried explosive hazard threats, including atomic magnetometers for nuclear quadrupole resonance (NQR), GPR, and frequency domain metal detectors; explored advanced signal processing approaches using correlated data from various modalities and determined optimal data processing and algorithm techniques; utilized outcome of optimal datasets as feedback to sensor redesigns and experimentation; determined highly accurate sensor position to improve feedback to reduce the operator's cognitive burden and improve clutter rejection. ***FY 2017 Plans:***	3.484	7.500	6.508

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602712A / *Countermine Systems*	**Project (Number/Name)** H24 / *Countermine Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will refine data collection processes to incorporate controlled, relevant outdoor environments with refined combinations of novel components and sensors that will be used for real-time detection and identification of buried explosive hazard threats; will continue to investigate advanced signal processing approaches and to design optimal data algorithms and processing techniques; will conduct data collections and analyses to verify the accuracy of sensor position designs and to determine the level of improvement in feedback to operators to reduce cognitive burden and reduce clutter. ***FY 2018 Plans:*** Will finalize combinations of novel components and sensors to support real-time detection and identification of buried explosive hazard threats in relevant outdoor environments; conduct experiments to confirm component designs and mature signal processing techniques; mature visualization components to enhance clutter rejection and improve operator interfaces; conduct limited user assessment of integrated breadboard design.			
Title: Counter Explosive Hazard Phenomonology ***Description:*** This effort investigates potential long term solutions to nonconventional explosive hazard threats. It leverages recent lessons learned to investigate new ideas and emerging technologies to counter explosive hazards through 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 structured and organized framework, enabling the Army to identify/assess opportunities to leverage technologies traditionally associated with other arenas, such as the intelligence community, big data, and the financial industry. ***FY 2016 Accomplishments:*** Continued the series of knowledge capture events with industry and academia; focused efforts on characterizing counter-IED detection phenomenology; continued analysis and began validation of research areas focusing on non-traditional approaches. ***FY 2017 Plans:*** Will continue the ongoing series of innovative investigation and informational events with industry and academia to collect information on previously unexplored phenomenologies; based on the knowledge gained from Fiscal Year (FY) 2015 and FY16 knowledge capture events, will evaluate and validate nonconventional Counter Explosive Hazard (CEH) technologies for buried or concealed explosive hazard detection, such as multi-static GPR, polarized ultraviolet (UV) radiation, and explore novel passive radio frequency (RF). ***FY 2018 Plans:*** Will evaluate and validate nonconventional CEH technologies for buried or concealed explosive hazard detection, such as novel neutron sources and gamma detectors for identification of buried explosive, and RF atomic magnetometers for discrimination	2.883	2.810	2.790

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602712A / *Countermine Systems*	**Project (Number/Name)** H24 / *Countermine Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
of buried man-made objects; continue the ongoing series of innovative investigation and informational events with industry and academia to collect information on previously unexplored phenomenologies.			
Accomplishments/Planned Programs Subtotals	18.686	20.821	20.453

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602712A / *Countermine Systems*	Project (Number/Name) H35 / *Camouflage & Counter-Recon Tech*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
H35: *Camouflage & Counter-Recon Tech*	-	5.400	5.676	5.737	-	5.737	6.863	7.997	8.120	8.286	-	-

A. Mission Description and Budget Item Justification

This Project investigates, designs and evaluates 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 Assistant 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 (U.S.) Army Communications-Electronics Research, Development and Engineering Center (CERDEC)/Night Vision and Electronic Sensors Directorate, Fort Belvoir, VA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Camouflage and Counter-Reconnaissance Technology for Advanced Spectral Sensors	5.400	5.676	5.737

Description: This effort investigates and advances new techniques to reduce susceptibility of sensors and signature reduction approaches to detection by lasers, Electro-Optic (EO) sensor systems and Infrared (IR) sensor systems. The primary objectives are to reduce the reflectivity of currently fielded and emerging EO and sensors and next generation camouflage nets due to incoming energy from lasers as well as EO and IR sensor systems.

FY 2016 Accomplishments:

Studied uncooled FPA resiliency against laser threats; investigated uncooled focal plane array (FPA) protection including Micro-electromechanical Systems (MEMS) devices and tunable IR filters; investigated best approach to harden daylight (Day-TV) cameras against laser threats; investigated methods of laser protection for high performance cooled IR sensors, including linear and non-linear optical approaches. Explored spectral response of next generation lightweight camouflage net systems, as well as different methods to imbed a thermal pattern into the net systems; optimized the performance of multispectral camouflage to counter emerging threats.

FY 2017 Plans:

Will investigate sensor vulnerabilities to future laser threats, and will develop algorithms and explore new materials, devices, and strategies to counter these threats; will develop sensor protection technologies that can be applied across multiple platforms; will continue to investigate techniques to minimize the spectral signatures of two-sided camouflage nets for desert and woodland environments; will investigate the colors, patterns and materials needed to design arctic camouflage patterns with minimal spectral

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602712A / *Countermine Systems*	**Project (Number/Name)** H35 / *Camouflage & Counter-Recon Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
signatures; will research future urban camouflage solutions for both vehicles and dismounts; will explore hyperspectral sensor technology to locate both red force and blue force targets in obscured locations. ***FY 2018 Plans:*** Will validate through experimentation optical cross section reduction methods for day television (TV) sensors; continue to investigate sensor vulnerabilities to future laser threats; research new materials, devices, and strategies to counter these threats; develop sensor protection technologies that can be applied to new day TV sensors employed on multiple platforms. Define signature reduction characteristics for urban and artic camouflage solutions for both vehicles and dismounts.			
Accomplishments/Planned Programs Subtotals	5.400	5.676	5.737

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602712A / *Countermine Systems*	Project (Number/Name) HB2 / *COUNTERMINE COMPONENT TECHNOLOGY (CA)*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
HB2: *COUNTERMINE COMPONENT TECHNOLOGY (CA)*	-	11.500	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Countermine Systems applied research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017
Congressional Add: Program Increase	11.500	-
FY 2016 Accomplishments: This is a Congressional Interest Item		
Congressional Adds Subtotals	11.500	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602716A *I Human Factors Engineering Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	23.220	23.671	24.127	-	24.127	25.160	25.365	25.877	26.408	-	-
H70: *Human Fact Eng Sys Dev*	-	23.220	23.671	24.127	-	24.127	25.160	25.365	25.877	26.408	-	-

A. Mission Description and Budget Item Justification

This Program Element (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.

Efforts in this PE support the Army Science and Technology Soldier/Squad portfolio.

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 Assistant Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work is performed by the Army Research Laboratory (ARL), Aberdeen, MD.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army					Date: May 2017
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*			R-1 Program Element (Number/Name) PE 0602716A / *Human Factors Engineering Technology*		
B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	23.681	23.671	24.034	-	24.034
Current President's Budget	23.220	23.671	24.127	-	24.127
Total Adjustments	-0.461	0.000	0.093	-	0.093
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.461	-			
• Civ Pay Adjustments	0.000	0.000	0.093	-	0.093

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602716A / *Human Factors Engineering Technology*	Project (Number/Name) H70 / *Human Fact Eng Sys Dev*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
H70: *Human Fact Eng Sys Dev*	-	23.220	23.671	24.127	-	24.127	25.160	25.365	25.877	26.408	-	-

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.

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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 Research Laboratory (ARL), Aberdeen, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Interfaces for Collaboration and Decision Making	2.658	2.699	2.756
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 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.			
FY 2016 Accomplishments: Identified and investigated aspects of information displays and interfaces that best support the effective conduct of tactical intelligence; validated the effectiveness of interface type and information presentation techniques in experimental decision aids			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*	**Project (Number/Name)** H70 / *Human Fact Eng Sys Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
such as the Warfighter Associate; and conducted research to identify elements critical to information display and presentation for the development of future decision aids applicable to civil-military, tactical (Company level), and cyber security. ***FY 2017 Plans:*** Will conduct fact extraction and analysis of data from complex networked teams (including civil-military), to inform development of technology for enhanced decision-making; and conduct research on data-to-decisions and decision-support technologies for cyber security, mission command and understanding of big data domains to enhance decision-making and collaborative performance. ***FY 2018 Plans:*** Will develop metric approach to quantify digital performance in human-system interactions; leverage current networking technology and recent advances in wearables and computer-mounted sensor technologies to collect and analyze large volumes of data to characterize behavioral, physiological, task-based and environmental factors influencing task performance and decision making of individuals and teams; develop cyber-security ontologies and scenarios to characterize human dynamics in the cyber domain using approaches such as game theory, artificial intelligence, cognitive modeling, multi-agent simulation, and online platforms for investigation.			
Title: Human Performance Modeling ***Description:*** Enhance human performance modeling tools to enable system analysis that will inform system design early in the acquisition process. These tools will allow the identification of design flaws that can be mitigated to reduce workload and human errors and increase user acceptance of developing technologies allowing the Soldier to extract the maximum performance from the equipment. Collect and analyze empirical data on human perception (vision and hearing) to support human and system performance models used for equipment design and training. Efforts are coordinated with Program Element (PE) 0602786A/H98 (Clothing and Equipment Technology). ***FY 2016 Accomplishments:*** Enhanced the analytic capabilities and usability of current human performance modeling tools by incorporating cognitive distraction driving scales, updating military specialty lists and improving reporting and visualization capabilities; expanded human figure digital library by developing three-dimensional (3D) models of Air Soldier clothing and equipment items to perform early human figure modeling assessments of future aviation platform designs; investigated the importance of coping style and working memory capacity for improved prediction of cognitive performance while driving; and investigated the feasibility of incorporating Soldier Systems Engineering Architecture (SSEA) drawings and Human View concepts into the Improved Performance Research Integration Tool (IMPRINT) to improve system design predictions and drive design requirements early in acquisition. ***FY 2017 Plans:***	2.620	1.128	0.506

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*	**Project (Number/Name)** H70 / *Human Fact Eng Sys Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will incorporate new cognitive demand scales and update micromodels within IMPRINT; and investigate the effects of physical and cognitive stress such as dehydration or vigilance on Soldier performance, and transition results to models. ***FY 2018 Plans:*** Will maintain and improve IMPRINT reporting and visualization capabilities; update new performance shaping functions within IMPRINT; research trustworthiness effects within communities and develop methods of using human performance modeling tools as a hybrid modeling architecture; and enhance accommodation modeling tools with improved H-point seated posture positioning for human figure modeling analysis.			
Title: Brain-Computer Interaction ***Description:*** Investigate the use of neurophysiological and behavior-based technologies for enhancing the interaction between Soldiers and systems such as autonomous systems and advanced crew stations. Implement guidelines for: algorithms for characterizing Soldier brain activity in operational contexts; real-time techniques to integrate neurally-based information into systems designs. ***FY 2016 Accomplishments:*** Investigated novel approaches for image analysis that fuse computer vision and brain-computer interaction technologies for enhanced target identification capabilities.capabilities. ***FY 2017 Plans:*** Will develop novel techniques that enable co-adaptation of multiple computer vision and brain-computer interface systems for distributed processing of large-scale image data. ***FY 2018 Plans:*** Will develop and integrate novel neural classification algorithms that enable brain-computer interaction technologies for image analysis to be used without requiring a calibration to the individual user.	3.273	2.288	3.540
Title: Dismounted Soldier Performance ***Description:*** Investigate equipment design standards and human performance measures and create guidelines for maneuver team information systems solutions that improve situational understanding and decision cycle time; identify, mature, and quantify human performance limitations to address future warrior performance issues. ***FY 2016 Accomplishments:*** Investigated the effects of cognitive stress on physical performance; developed techniques to employ basic science principals discovered in highly controlled laboratory experiments in more operationally relevant environments using more militarily relevant physical and cognitive stressors to enhance research results; conducted research to inform guidelines for equipment developers	6.221	7.507	5.256

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*	**Project (Number/Name)** H70 / *Human Fact Eng Sys Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
and the Research and Development Centers that will enhance Soldier and small team performance; investigated the effects of small arms recoil on shooter performance and transition results to research and development centers and the United States (U.S.) Army Marksmanship Unit. ***FY 2017 Plans:*** Will examine the tradeoffs between ballistic armor coverage area, armor plate design and mobility to quantity the effect to Soldier performance; conduct research to provide a greater understanding of the effects of physical augmentation (such as exoskeleton devices) on Soldier performance; examine the effects of physical load mitigation technologies on physical performance; investigate the effects of motivation on cognitive performance for individuals and small teams; and examine the effects of prolonged physical stress on physical and cognitive performance. ***FY 2018 Plans:*** Will work to understand the underlying mechanisms by which physical load (equipment mass, physical fatigue, etc.) affects dismounted Soldier performance; investigate the effects of team interaction on operationally relevant cognitive and physical tasks; work to quantify the effect of human variability on the performance of small arms shooting accuracy, and determine ways of mitigating negative effects.			
Title: Human-Robot Interaction ***Description:*** Design human-centered design requirements and technologies for supervision and Soldier interaction with multiple semi-autonomous unmanned vehicles in urban and unstructured environments. This research will be transitioned to U.S. Army Tank Automotive Research Development and Engineering Center (TARDEC). ***FY 2016 Accomplishments:*** Developed concepts for efficient Soldier-robot interaction and teaming, multimodal bidirectional communication between Soldiers and autonomous systems, and trust and transparency between Soldier and robot; and investigated the impact of social-cultural context on usage of autonomous systems in coordination with the ARL Autonomous Systems Enterprise partners. ***FY 2017 Plans:*** Will develop and assess multimodal bidirectional communication solutions, including natural language, gesture, and tactile methods, for effective Soldier-agent interaction and teaming; and develop models of trust and transparency as basis for human-centered design requirements for intelligent, autonomous systems. ***FY 2018 Plans:*** Will refine multimodal bidirectional communications solutions, including natural language and language-based methods, for effective Soldier-agent interaction and teaming; enhance models of trust and transparency to serve as basis for human-centered	2.965	2.998	3.054

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*	**Project (Number/Name)** H70 / *Human Fact Eng Sys Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
design requirements for intelligent, autonomous systems; both bidirectional communications and trust and transparency will be considered in a variety of applications, including multi-human, multi – intelligent agent, distributed systems.			
Title: Understanding Socio-cultural Influence ***Description:*** Investigate and model cognitive aspects of socio-cultural influences on Soldier/Commander decision making and communication to enhance Soldier performance with systems, within teams and in the mission context. Extend models of individual and teams to societal levels to support regional understanding, training, mission rehearsal, and influence. This work complements and is coordinated with PE 0602784A/T41 (Socio/Cultural Behavior) and PE 0602785A/790 (Personnel Performance & Training Technology). ***FY 2016 Accomplishments:*** Conducted experiments on the effectiveness of information presentation using the socio-culturally informed design principles; integrated cognitive framework into select experimental decision support and training tools and validated tools with experiments designed to determine if relevant socio-cultural information is presented effectively to enhance Soldier decision making in diverse environments. ***FY 2017 Plans:*** Will develop metrics and supporting models to map the effect of socio-cultural factors on Soldiers' decision-making, and improve asymmetric threat forecasting to inform battlefield operations; and develop representative algorithms of social-cultural variables to integrate into models that will predict adversary behavior. ***FY 2018 Plans:*** Will validate new social cultural representation models integrating civil affairs and intelligence social-cultural expertise into the US Army's Common Operating Picture to augment the Commander's military decision making process; identify sociocultural influences that facilitate teaming amongst socio-cultural diverse groups; develop an ontological framework of these influences and interactions to obtain a better understanding of cause and effect and to support predictive model development.	1.980	2.029	2.060
Title: Continuous Multi-Faceted Soldier Characterization for Adaptive Technologies ***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. ***FY 2017 Plans:***	-	1.600	2.259

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*	**Project (Number/Name)** H70 / *Human Fact Eng Sys Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will develop techniques to integrate behavioral, physiological, environmental, and task-based sensors to enable continuous low resolution multi-faceted monitoring of an individual. ***FY 2018 Plans:*** Will demonstrate capability for real-time performance assessment using novel techniques for aggregation, storage and access of individual specific, low-resolution, longitudinal data from a combination of behavioral, physiological and task domains.			
Title: Soldier Sensory Performance ***Description:*** Conduct Soldier-oriented research to understand the attentional and cognitive challenges of interpreting unaided and aided tactile signals, visual imagery, and auditory events in complex, dynamic battlefield environments. Results are used for enhancing sensory performance by providing the materiel development community with the knowledge necessary to effectively design systems that maximize mission effectiveness and survivability of the dismounted Soldier. ***FY 2016 Accomplishments:*** Conduced Soldier-centric research on personnel-borne improvised explosive device (IED) detection technologies to characterize operator/system strengths and constraints, and maximizing IED detection performance; conducted research on enhancements to night-vision goggle technologies, including studies designed to optimize processing parameters (e.g., image latency and frame rate) for electronically coupled night-vision and thermal detection systems; continued to support equipment development by providing human auditory performance data to Research Development and Engineering Centers (RDECs) in order to develop evaluation standards that are tied to the impact of auditory capabilities on operational requirements; conducted a study to examine the efficacy of two-way tactile communication to support squad-level communications; explored the integration of bone conduction technology communication systems into chemical, biological, radiological and nuclear protective masks to improve Soldier communication and validate their effectiveness in a field environment. ***FY 2017 Plans:*** Will develop models of target saliency and concepts for training methodologies to enhance IED detection performance; validate concepts of integrating bone conduction communications systems into chemical, biological, radiological and nuclear protective masks as an improvement to Soldier communication and performance; and characterize operator/system performance capabilities of night vision devices (NVDs) to support development of digital sensor technology.	1.444	1.485	-
Title: Training Effectiveness Research ***Description:*** Novel technologies and their implementation in Army systems may result in demands on Soldiers that exceed their knowledge, skill, or memory capacity. When demands cannot be remediated by human systems integration, training may enable the demands to be met. This effort will identify human operator tasks in complex, intelligent, and emerging systems critical to mission employment of new technologies. The aspects (particularly knowledge and skill) of those tasks will be determined	0.980	0.937	0.932

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*	**Project (Number/Name)** H70 / *Human Fact Eng Sys Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
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. This effort leverages research from PE 0601102A/74A (Human Engineering) and will be transitioned to PE 0603015/S29 (Next Generation Training and Simulation Systems). ***FY 2016 Accomplishments:*** Identified user skills that are critical to interacting with intelligent, autonomous systems and appropriate methods for measuring the user's skill level; and identified and matured approaches for evaluating the effectiveness of various types of training to conduct select human operator tasks. ***FY 2017 Plans:*** Will develop automated performance measurement capabilities for use in evaluating the effectiveness of training; and conduct research on the integration of multi-sensor data (e.g. accuracy, communications, psycho-physiological, and/or movement/location) for automated measurement of critical training outcomes and perform validation studies assessing metrics (algorithms) of training performance in virtual test-bed and live training environments. ***FY 2018 Plans:*** Will refine research-based integration of multi-sensor data (e.g. accuracy, communications, psycho-physiological, and/or movement/location) for automated measurement of critical training outcomes; conduct research to validate training performance assessment algorithms for virtual test-bed and live training environments; refine and validate automated performance measurement capabilities for use in evaluating the effectiveness of training.			
Title: Soldier System Architecture ***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. This research supports the development of the SSEA and is coordinated with PE 0602786A/H98, 0603015A/S28, PE 0603710A/Project K70, PE 0602308A/C90, PE 0602787A/869, and 0603004A/232. ***FY 2016 Accomplishments:*** Developed model-based predictive analyses of Dismounted Infantry (DI) missions that will provide Department of Defense (DoD) leadership with analytic data to inform requirements development and trade-off decisions as early as Milestone A. These	1.079	1.000	1.004

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*	**Project (Number/Name)** H70 / *Human Fact Eng Sys Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
analyses will integrate Human Systems Integration and Systems Engineering inputs to generate critical tasks combinations that provide the necessary analytical data to support cognitive workload measurement, MOEs, and MOPs for DI. ***FY 2017 Plans:*** Will develop an analysis methodology and proof of concept front end analysis tool for SSEA; and develop operational scenarios to examine cognitive, physical, and social aspects of performance to exercise within SSEA. ***FY 2018 Plans:*** Will conduct experiments on Soldier Resilience (arousal) and Effects of Stress on Soldier performance to shoot, move, and communicate. Purpose is to collect output data informing future model development and supporting SSEA scenarios at the tactical level of warfare. Will validate SSEA analysis methodology and proof-of-concept front-end analysis tool in a military relevant context.			
Title: Rapid Soldier Capability Enhancement ***Description:*** Research the relationship of augmentation agents and Soldier performance & behavior. Investigates the effects of augmentation agents (perceptual, cognitive, and/or physical), used either individually or coupled as a system of agents, on Soldier performance, resilience, and training during operationally relevant tasks. Development of guidelines and models for designing and employing augmentation agents. Implementation of guidelines will enhance augmented Soldier performance. ***FY 2018 Plans:*** Will investigate augmentation application, including timing, amplitude, and duration relative to biological and environmental signals, to understand functionality in varied and complex environments. Model performance and adaptation to augmentation agents in order to predict capability enhancement; investigate individual variability and short and long term adaptation to augmentation agents. Plan to investigate the extension of methods and metrics developed for single augmentation agent to the quantification of Soldier performance while using a system of augmentation agents.	-	-	2.760
Accomplishments/Planned Programs Subtotals	23.220	23.671	24.127

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*	**Project (Number/Name)** H70 / *Human Fact Eng Sys Dev*

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602720A *I Environmental Quality Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	20.270	22.151	21.678	-	21.678	21.818	22.201	22.665	24.149	-	-
048: *Ind Oper Poll Ctrl Tec*	-	2.320	2.718	2.860	-	2.860	2.901	2.967	3.025	3.089	-	-
835: *Mil Med Environ Crit*	-	6.759	7.803	8.005	-	8.005	8.043	8.200	8.364	8.534	-	-
895: *Pollution Prevention*	-	3.337	3.474	2.473	-	2.473	2.474	2.473	2.542	3.614	-	-
896: *Base Fac Environ Qual*	-	7.854	8.156	8.340	-	8.340	8.400	8.561	8.734	8.912	-	-

A. Mission Description and Budget Item Justification

This Program Element (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, and advanced remediation of Army-unique hazardous and toxic wastes at sites containing waste ammunition, explosives, heavy metals, propellants, smokes, chemical munitions, and other organic contaminants. 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 and airspace to reduce or eliminate environmental constraints to military missions.

The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy and supports the Army Strategy for the Environment.

Technologies developed in this PE are transitioned to PE 0603728A (Environmental Quality Technology Demonstrations).

Work in this PE is performed by the Army Engineer Research and Development Center, Vicksburg, MS, and the Army Research, Development, and Engineering Command, Aberdeen Proving Ground, MD.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army					Date: May 2017
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*			R-1 Program Element (Number/Name) PE 0602720A / *Environmental Quality Technology*		
B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	20.850	22.151	22.640	-	22.640
Current President's Budget	20.270	22.151	21.678	-	21.678
Total Adjustments	-0.580	0.000	-0.962	-	-0.962
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.580	-			
• Adjustments to Budget Years	0.000	0.000	-1.000	-	-1.000
• Civ Pay Adjustments	0.000	0.000	0.038	-	0.038

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602720A / *Environmental Quality Technology*	Project (Number/Name) 048 / *Ind Oper Poll Ctrl Tec*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
048: *Ind Oper Poll Ctrl Tec*	-	2.320	2.718	2.860	-	2.860	2.901	2.967	3.025	3.089	-	-

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.

The work in this Project supports the Army Science and Technology (S&T) Innovation Enablers Portfolio.

The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy and supports the Army Strategy for the Environment.

Work in this Project is performed by the Army Engineer Research and Development Center, Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Sustainable Ranges and Lands	1.388	1.763	1.893
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.			
FY 2016 Accomplishments: Developed a training land conflict analysis framework that accounts for current and future live training requirements and Threatened and Endangered Species (TES) distributions to assess impacts of proposed species listings on training land requirements; investigated innovative techniques for assisted species movement to minimize potential training impacts to Army			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*	**Project (Number/Name)** 048 / *Ind Oper Poll Ctrl Tec*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
lands; explored the use of low-cost manufactured social cues for listed and at-risk species as a non-invasive means of moving species away from conflict with current and proposed live training land use requirements. ***FY 2017 Plans:*** Will develop methodologies for identifying and quantifying potential impacts to training by current and future TES. Will develop novel training land conflict analysis algorithms that quantify and predict military training land use requirements to identify conflicts between TES and training on Army installations and mitigation strategies. Will develop innovative and cost-effective techniques to implement regional and installation TES conflict mitigation strategies that facilitate species movement from areas in conflict with training to areas not in conflict. Will explore biologically inspired sensing capabilities to enhance endangered species management strategies on Army lands and ranges. ***FY 2018 Plans:*** Will investigate relationships and relational patterns between physical and social data in select contingency areas of concern to enable Military security planners to anticipate climate and extreme weather induced impacts to security and readiness threats. Will research relational changes in environmental variability data and changes in human behavior to assess correlation with social-environmental trends and conflict trends as seen in hazard and conflict models.			
Title: Adaptive & Resilient Installations ***Description:*** This effort develops sustainable, cost efficient, and effective facilities; and provides technologies and techniques for achieving resilient and sustainable installation and base operations. ***FY 2016 Accomplishments:*** Developed and evaluated the next generation of water production and distribution capabilities through the development of wastewater treatment/reuse and water quality monitoring technologies. ***FY 2017 Plans:*** Will investigate biologically inspired materials and concepts for fouling resistance, as well as microbes that enhance in situ performance for water sustainment technologies to minimize external net water demand at Army contingency bases. ***FY 2018 Plans:*** Will investigate new coatings that promote water vapor deposition and shedding coupled with current waste vapor streams/ sources. Will investigate closed loop water treatment process technologies to determine best candidates in Army relevant conditions for contingency bases.	0.932	0.955	0.967
Accomplishments/Planned Programs Subtotals	2.320	2.718	2.860

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*	**Project (Number/Name)** 048 / *Ind Oper Poll Ctrl Tec*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602720A / *Environmental Quality Technology*	Project (Number/Name) 835 / *Mil Med Environ Crit*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
835: *Mil Med Environ Crit*	-	6.759	7.803	8.005	-	8.005	8.043	8.200	8.364	8.534	-	-

A. Mission Description and Budget Item Justification

This Project investigates a quantitative means to determine the environmental effects resulting from exposure to Army-unique explosives, propellants, smokes, and products containing nanomaterials and new and emerging compounds and materials across Army training and operations. This research provides the basis for tools and methods to respond to regulatory constraints, and to protect the health of the Soldier and the extended Army community. Results of this research will be integrated into the life cycle analysis of all new Army materials and chemicals. The specific results of this research include: determination of acceptable contaminant concentration levels for residual Army-unique chemicals and materials of concern to minimize adverse effects on the environment and human health. This includes development of methods that guide the design of nanomaterials and other new and emerging materials such that adverse effects on the environment are minimized in their designed state and when they enter the environment where they may break down. Example areas of research include genomics analysis, cutting edge nanomaterial analysis, and computational/molecular modeling. Interim products are used by Program Executive Office (PEO) Ammo and PEO Intelligence, Electronic Warfare & Sensors (IEW&S) for use in life cycle analysis, risk assessment, and cleanup. Interim products are also US Environmental Protection Agency approved criteria documents to be used in risk assessment procedures and in establishing regulatory limits. The Army uses these criteria during negotiations with regulatory officials to set scientifically and economically appropriate cleanup and discharge limits on Army lands.

Work in this Project supports the Army Science and Technology (S&T) Innovation Enablers Portfolio.

The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy and supports the Army Strategy for the Environment.

Work in this Project is performed by the Army Engineer Research and Development Center, Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Life Cycle of Military Materials in the Environment	4.198	3.460	1.200
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 2016 Accomplishments: Devised more extensive hazard screening tools for life cycle assessments to enable sustainable development of insensitive munitions and acquisition streamlining by providing proactive, relevant information on hazard risks; developed software tools			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*	**Project (Number/Name)** 835 / *Mil Med Environ Crit*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
containing methods and modules for science-based improvements with improved characterization factors for environmental impact of military unique hazardous materials. ***FY 2017 Plans:*** Will investigate environmental life cycle, health, and safety impacts from potential exposure to evolving insensitive military munitions, constituents, and unique materials impacting next generation weapons systems. ***FY 2018 Plans:*** Will develop a new eco-toxicity life cycle assessment framework designed to optimize the cost-benefit of environmental data collections to address pre-Milestone B environmental assessment guidelines.			
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. ***FY 2016 Accomplishments:*** Devised a tiered environment, health, and safety evaluation process with supporting test/screening methodologies that will enable rapid fielding and sustainability of current and future Army nanotechnologies and facilitate reduced time and cost of acquisition; developed a consistent process for nanotechnology risk screening to enable sustainable development, transition, and acquisition that address liability concerns that often result in technology delays or termination. ***FY 2017 Plans:*** Will investigate the unique properties of nanomaterials utilized in munitions to determine environmental fate and impact. Will utilize understanding of nanomaterial properties to develop next generation remediation technologies for Army unique contaminants. ***FY 2018 Plans:*** Will investigate and categorize technologies of military relevant advanced and additive materials, including nanotechnologies and additive manufacturing techniques, to discriminate high and low risk areas as relevant to Chemical Data Reporting under the Toxic Substances Control Act.	2.561	3.013	3.063
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 develops advanced engineering concepts utilizing advanced materials, biological processes, and nanomaterials in remediation processes. ***FY 2017 Plans:***	-	1.330	3.742

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*	**Project (Number/Name)** 835 / *Mil Med Environ Crit*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will research data driven predictive frameworks and tools for assessment of on-site bioremediation technologies for contaminated soils and groundwater that facilitate adaptive installation management under the paradigm of changing Arctic/Subarctic climates. ***FY 2018 Plans:*** Will develop empirical datasets of soil structure, geochemistry, and microbial community composition and function from bench and medium-scale studies to identify on-site contaminant degradation processes and limitations in arctic and subarctic climates. Will investigate the most relevant metrics needed to characterize synthetic biology environmental impacts of military relevance and quantify their relative importance.			
Accomplishments/Planned Programs Subtotals	6.759	7.803	8.005

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602720A / *Environmental Quality Technology*	Project (Number/Name) 895 / *Pollution Prevention*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
895: *Pollution Prevention*	-	3.337	3.474	2.473	-	2.473	2.474	2.473	2.542	3.614	-	-

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 Assistant Secretary of Defense, Research and Engineering Science and Technology priority focus areas.

Technologies developed in this Project are fully coordinated and complementary to Program Element (PE) 0603728A, Project 025.

Work in this Project is performed by the Research, Development and Engineering Command Army Research Laboratory, Aberdeen Proving Ground, MD, the Armaments Research, Development, and Engineering Center, Picatinny Arsenal, NJ, the Aviation and Missile Research, Development, and Engineering Center, Huntsville, AL, and the Tank Automotive Research, Development and Engineering Center, Warren, MI.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Pollution Prevention Technologies	3.337	3.474	2.473
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.			
FY 2016 Accomplishments: Conventional Ammunition: Developed precision loading processes for novel lead-free primer formulations; Rocket and Missile Propellants: Conducted static motor testing of novel lead-free burn rate modifiers in minimum signature applications; Toxic Metal Reduction: Developed and refined portable hexavalent chromium-free process for generating wear resistant surface coatings.			
FY 2017 Plans:			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*	**Project (Number/Name)** 895 / *Pollution Prevention*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will develop novel green chemistry approaches to energetic material synthesis; will reformulate metal-rich primers to reduce harmful pollutants while improving corrosion protection; will explore candidate fire suppressants with low global warming potential to determine their viability in military applications. ***FY 2018 Plans:*** Will optimize green synthesis methods for melt cast explosives as potential alternatives to trinitrotoluene (TNT); will explore synthesis of novel high nitrogen primary explosive compounds to replace lead used in primers and detonators; will develop sustainable coatings for magnesium protection and electromagnetic shielding of aircraft; will conduct laboratory-scale performance testing on alternative fire suppressants with low global warming potential.			
Accomplishments/Planned Programs Subtotals	3.337	3.474	2.473

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602720A / *Environmental Quality Technology*	Project (Number/Name) 896 / *Base Fac Environ Qual*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
896: *Base Fac Environ Qual*	-	7.854	8.156	8.340	-	8.340	8.400	8.561	8.734	8.912	-	-

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 sustainable use of Army facilities, training lands, firing ranges, and airspace to reduce or eliminate environmental constraints to military and how the use of those resources effect mission support and environmental compliance. 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 of training and testing areas needed for realistic and sustainable ranges and training lands. Technologies within this Project enable users to match mission events and training schedules with the resource capabilities of specific land areas and understand technologies to adapt and restore lands damaged during training activities and allow sustained use of Army resources. The Project supports readiness and full use of training lands through development of invasive, threatened, and endangered species monitoring technology, and management technologies for species at risk. The Project also designs and develops tools and technologies to avoid training restrictions and reduce constraints on training lands associated with potential impacts from climate change.

Work in this Project supports the Army Science and Technology (S&T) Innovation Enablers Portfolio.

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 and supports the Army Strategy for the Environment.

Work in this Project is performed by the Army Engineer Research and Development Center, Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Sustainable Ranges and Lands	3.848	4.056	4.150
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.			
FY 2016 Accomplishments: Developed capabilities that incorporate direct and indirect impacts of climate change and related trending dynamic conditions into critical Army enterprise decisions; provided a tiered approach to climate change impact assessments that scale from local to national scale applications. Extended climate change assessment analyses to include maneuver area capacity, live-fire range			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*	**Project (Number/Name)** 896 / *Base Fac Environ Qual*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
capacity, and facility operations and maintenance costs. Developed advanced military noise assessment capabilities that rapidly characterize military noises, uncertainties, and impacts to allow installations to comprehensively characterize and adaptively manage their noise footprint, impacts, and restrictions. Developed algorithms that transform geostatistical military noise maps from installation noise monitoring systems into community impact maps. ***FY 2017 Plans:*** Will complete development of a suite of analysis tools that will provide climate-sensitive metrics using underlying models that are based on the best scientific understanding of climate-change impacts and related dynamics. These tools will integrate climate-change forecasts and data to assess impacts to installation decision metric values that affect Army enterprise planning decisions. Will develop innovative noise detection, classification, and location algorithms that translate raw discrete multi-sensor noise monitoring data into source specific event groups of known identities and locations to cost effectively automate management of installation noise monitoring systems. Will develop data driven, self-learning, adaptive military noise forecast algorithms that utilize installation site-specific noise monitoring data for improved prediction of noise levels, certainty, and community impact. ***FY 2018 Plans:*** Will investigate tools, algorithms, procedures and guidance to manage installation noise in real-time; develop integrated simulation tools that incorporate weather, terrain, and mission activity into forecasting models for probability of noise complaints; investigate alternative TES management strategies and supporting technologies to respond to emerging TES mitigation policies; develop methodologies for prioritizing regional-level TES management strategies to minimize training impacts due to listed species.			
Title: Military Materials in the Environment	4.006	4.100	4.190
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. ***FY 2016 Accomplishments:*** Applied a multidisciplinary approach (geochemical, geographical, soil science, and computational chemistry) to develop an understanding of soils and contaminants in austere environments; applied sophisticated genetic algorithms to develop empirical and validated functions correlating soil morphological designations to multidimensional soil geochemical properties. ***FY 2017 Plans:*** Will determine soil designations among soil taxonomy systems to form the basis for developing calibrated soil process models. Will devise a robust predictive model that is capable of using inherent soil characteristics to determine the potential risks associated with environmentally relevant military activities (i.e. fate and transport of contaminants). The model design will address			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*	**Project (Number/Name)** 896 / *Base Fac Environ Qual*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
a large array of environmental quality problems associated with both the Continental United States (CONUS) and Outside of the Continental United States (OCONUS) military activities. ***FY 2018 Plans:*** Will validate a robust predictive model that is capable of using inherent soil characteristics to determine the potential risks associated with environmentally relevant military activities (i.e. fate and transport of contaminants). Will investigate computational approaches for important physical and chemical properties of insensitive munitions compounds in water, arid, and semi-arid environments to predict their fate and effects in natural water and in arid or semi-arid soils. Will generate a computational model to predict potential chemical-biological interactions at the molecular level for assessment of military compounds.			
Accomplishments/Planned Programs Subtotals	7.854	8.156	8.340

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army	Date: May 2017
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602782A *I Command, Control, Communications Technology*

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
Total Program Element	-	34.749	37.803	33.123	-	33.123	37.798	36.530	37.010	34.227	-	-
779: *Command, Control And Platform Electronics Tech*	-	15.190	16.444	12.837	-	12.837	13.148	13.426	13.959	12.228	-	-
H92: *Communications Technology*	-	19.559	21.359	20.286	-	20.286	24.650	23.104	23.051	21.999	-	-

A. Mission Description and Budget Item Justification

This Program Element (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 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 (Electronic Warfare Technology), PE 0603772A (Advanced Tactical Computer Science and Sensor Technology), and PE 0603794A (Command, Control and Communications Advanced Technology), and is coordinated with PE 0601104A (University and Industry Research Centers), PE 0602120A, (Sensors and Electronic Survivability), PE 0602783A (Computer and Software Technology), and PE 0602874A (Advanced Concepts and Simulation).

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 in this PE is performed by the Army Research, Development, and Engineering Command (RDECOM), Communications-Electronics Research, Development, and Engineering Center (CERDEC), Aberdeen Proving Ground, MD.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army					Date: May 2017
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*			**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*		
B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	36.160	37.803	39.092	-	39.092
Current President's Budget	34.749	37.803	33.123	-	33.123
Total Adjustments	-1.411	0.000	-5.969	-	-5.969
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.411	-			
• Adjustments to Budget Years	0.000	0.000	-6.079	-	-6.079
• Civ Pay Adjustments	0.000	0.000	0.110	-	0.110

Change Summary Explanation

Fiscal Year (FY) 2018 funding decreased to support higher priority efforts.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602782A / *Command, Control, Communications Technology*	Project (Number/Name) 779 / *Command, Control And Platform Electronics Tech*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
779: *Command, Control And Platform Electronics Tech*	-	15.190	16.444	12.837	-	12.837	13.148	13.426	13.959	12.228	-	-

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.

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 in this Project is performed by the Army Research, Development, and Engineering Command (RDECOM), Communications-Electronics Research, Development, and Engineering Center (CERDEC), Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Assured Positioning, Navigation, and Timing (A-PNT)	4.532	5.690	7.313
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, Work being accomplished under Program Element (PE) 0603772A/Project 101 complements this effort.			
FY 2016 Accomplishments: Investigated microelectromechanical systems (MEMS) sensors, anti-jam/anti-spoof antennas, multi-frequency Global Navigation Satellite System (Multi-GNSS) receivers that incorporate M-code capability; researched the application of laser-based light detecting and ranging (LIDAR) as an improvement over visible light vision systems; investigated a common interface for PNT applications to enable the seamless incorporation of new sensors; researched the application of atomic sensors for gyros, accelerometers and clocks for independent location information using no external signals; explored the feasibility of integrating star trackers with terrestrial PNT systems; researched performance effects on navigation solutions when incorporating a variety of emerging PNT technologies such as cameras with rolling vs. global shutters; matured Blue Force Electronic Attack (BFEA) models			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*	**Project (Number/Name)** 779 / *Command, Control And Platform Electronics Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
and simulations to emulate and account for M-code enabled GPS receivers; conducted experiments with various technologies to provide PNT for autonomous vehicles. ***FY 2017 Plans:*** Will design and develop software tools to support the location and adjustment of pseudolite and autonomous navigation assets on the battlefield to maximize PNT information availability; expand upon research in celestial navigation to include tow-way time transfer techniques for independent localization and time for pseudolites in GPS denied environments; conduct research involving LIDAR odometry, visual navigation, and map building to help aid integrated navigation systems and improve the PNT solution accuracy and jam resistance for mounted, dismounted, and autonomous applications; investigate new anti-jam antenna designs for anti-spoofing capabilities; continue research in and fabrication of new and emerging inertial sensors in collaboration with the Army Research Laboratory and the Defense Advanced Research Projects Agency to reduce the size and increase the accuracy of these devices, allowing them to provide accurate position information for longer periods of time when GPS signals are lost or jammed; mature radio frequency (RF) ranging and positioning sensor components and algorithms to further augment GPS signals, provide precise position information and shorten time to first fix; design a PNT simulation architecture and framework; design and code models with selectable fidelity for PNT components, devices, and systems of the Army and other Services; perform analyses and studies using PNT models to assess their usefulness to support Army and other Service science and technology efforts and acquisition decisions. ***FY 2018 Plans:*** Will investigate includes new methods of time transfer and novel ways to reduce size, weight and power for micro autonomous pseudolites to create expendable pseudolites that minimize the risks resulting from compromised assets; conduct research on machine learning concepts applied to navigation of autonomous vehicles to improve an autonomous vehicle's localization and movement through a complex environment over time; continue investigation through an iterative process of design, fabrication, and test for size and performance improvements to miniature inertial sensors to augment PNT in GPS denied environments; complete validation of the use of Multi Global Navigation Satellite Systems signals (signals from foreign nation navigation satellite systems) in military applications; investigate new signals of opportunity for augmenting positioning and timing solutions on the battlefield; research dismounted anti-jam (AJ) technologies, such as wearable fabric antenna systems; explore potential applications for leveraging the new M-Code GPS signal for offensive and defensive navigation warfare operations; and develop models of PNT sensors, systems, and platforms and conduct simulations of operational scenarios to support Department of Defense (DoD) analysis of the behaviors of PNT devices and the effects these sensors have on the capabilities of United States (U.S.) forces, especially under GPS challenged conditions.			
Title: Next Generation Mission Command Technologies ***Description:*** This effort investigates, designs and codes software to enable a uniform MC capability and experience for the commander in the command post, on the move in vehicles, or dismounted, increases the situational awareness through software	10.658	10.754	5.524

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*	**Project (Number/Name)** 779 / *Command, Control And Platform Electronics Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018

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. Work being accomplished under PE 0603772A/Project 101 complements this effort.

FY 2016 Accomplishments:

Designed and validated an infrastructure and software architecture that permits a single source code base to deploy MC applications across different platforms in the command post, mounted and dismounted environments; investigated a virtual staff capability to supply staff-like functionality to the commander; matured software that enables small unit commander-centric operations by helping the commander to drive the operations process and assist in unit to unit and cross coalition interaction; investigated how to include human factors engineering early into MC software designs in order to simplify user interactions with the software and reduce cognitive load on the Soldiers; designed software to perform MC of teams of humans and multiple autonomous systems to augment unit effectiveness and unburden Soldiers by eliminating multiple complex interfaces with the autonomous systems.

FY 2017 Plans:

Will investigate and develop software that will help the commander and staff define what MC tasks must be performed in order to insure mission success, help to optimally assign those tasks to resources such as Soldiers, track how the tasks are being completed, and support any needed adjustments to the mission tasks; develop software to display what is known about enemy actions in easy to understand ways and show how those actions will impact the current mission; develop software to process the needed mission tasks and enemy actions and generate recommendations suggesting courses of action that were successful in similar circumstances in the past; develop software that will help the commander and staff to interoperate more effectively by enabling the commander to easily make and track staff assignments and to quickly access staff reports, estimates, and recommendations regardless of the commanders physical location; continue to investigate how to determine which mission tasks can be given to unmanned systems (robots) to execute; investigate technologies to limit needed human involvement in unmanned system task execution; develop software to help planners to integrate multiple and different types of unmanned systems into a team with shared tasks in order to achieve mission success.

FY 2018 Plans:

Will further research in the second of a three year effort to develop a software model that is a knowledge representation of a mission to enable automation of tasks such as developing course of action and staff assignment recommendations; research and develop a framework with standard interfaces that allows externally developed software to communicate with the mission model and leverage the data to perform real time analytics such as continuous power predictions for the mission; research and refine business process modeling technologies to assist users with dynamic and reusable workflows that align with the military

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*	**Project (Number/Name)** 779 / *Command, Control And Platform Electronics Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
decision making process or a unit's standard operating procedures; and complete research and investigation of several artificial intelligence techniques including machine learning and intelligent agents that will be down selected and implemented in Fiscal Year (FY) 2019 and FY 2020 to assess the mission objectives and current situation to help with situational understanding by providing visualizations of how the situation is deviating from intent with continuous running estimates and an on-going analysis of risks and opportunities.			
Accomplishments/Planned Programs Subtotals	15.190	16.444	12.837

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602782A / *Command, Control, Communications Technology*	Project (Number/Name) H92 / *Communications Technology*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
H92: *Communications Technology*	-	19.559	21.359	20.286	-	20.286	24.650	23.104	23.051	21.999	-	-

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 cyber electromagnetic activities (CEMA), 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. This Project also investigates software and techniques that improve the ability of the Soldier to manage and maintain complex, dynamic networks; and it design and develops spectrum management software tools to make more efficient use of the congested RF spectrum. This Project also provides new capabilities to lower the size, weight, power and cost of networking systems deployed on Army platforms.

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 in this Project is performed by the Army Research, Development, and Engineering Command (RDECOM), Communications-Electronics Research, Development, and Engineering Center (CERDEC), Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Antenna and Hardware Technologies	1.568	3.425	-
Description: This effort investigates low cost, power efficient, conformal and directional antenna technologies for terrestrial, airborne, and tactical SATCOM ground terminals to enable them to operate OTM over multiple frequency bands, and itfurther investigates armor embedded antenna and distributed array technologies. Together these efforts will improve ground forces electronic protection, increase signal power and range and provide greater connectivity for both mounted and dismounted forces. Work being accomplished under Program Element (PE) 0602270A/project 906, PE 0603270A/project K15 and PE 0603794A/ Project EL4 complements this effort. In Fiscal Year (FY) 18 a majority of these efforts, along with several efforts currently under Future Communications and Networking Technologies, will be reported under a new thrust, entitled “Networking to Improve			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*	**Project (Number/Name)** H92 / *Communications Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Maneuver and Expeditionary Operations", in order to better focus efforts in related and evolving technologies. A few of the efforts herein will be reported in another new thrust area entitled "Uninterrupted Communications". ***FY 2016 Accomplishments:*** Completed and demonstrated in a lab environment a smart switch for distributed antenna arrays enabling higher output power, interoperability and improved link connectivity for SATCOM; completed and demonstrated in a lab environment antennas and antenna arrays that provide improved communications performance and reliability through electronic warfare (EW) jammed environments; and designed and developed a government standard architecture to provide standard form-fit and electronic interfaces for distributed terrestrial antenna systems. ***FY 2017 Plans:*** Will finalize a Government standard architecture to provide standard form-fit and electronic interfaces for distributed terrestrial antenna systems for ground vehicle and command post application; explore architecture approaches and potential benefits of upgrading conventional analog intermediate frequency (IF)-based SATCOM terminal designs to digital IF systems for enhanced flexibility and performance, reduced footprint and cost and improvement of features such as monitoring, alarms and built in test capabilities.			
Title: Networking to Improve Maneuver and Expeditionary Operations	-	-	4.508
Description: This effort formulates new capabilities to provide a range of robust, reliable, scalable, interoperable and resource efficient communications capabilities to expeditionary forces on the move. These capabilities allow forces to conduct early entry operations, develop situational understanding, and sustain operations while maintaining freedom of movement. Starting in FY18 the "Antenna and Hardware Technologies" and "Future Communications and Networking Technologies" efforts are reorganized into this new thrust area and the new "Uninterrupted Communications" thrust area. ***FY 2018 Plans:*** Will research, brassboard, and conduct laboratory experiments on new short range wireless transmission technologies to improve performance and robustness of secure wireless personal area networks for on-Soldier sensors and ancillary devices; conduct studies, simulations, laboratory experiments and provide incremental enhancements to commercial wireless technologies, such as cellular Long Term Evolution (LTE), to adapt them for use in the tactical environment as a low cost and rapidly adaptive capability to the warfighter; conduct research, simulations and lab experiments for next generation terrestrial and SATCOM radios and code waveform protocols to conduct reliable communications in austere environments; conduct analysis, simulations and lab experiments to design and code networking protocols for network relays to be carried by autonomous systems and to optimize networking capabilities rsulting from autonomous maneuvering of these relays on the battlefield; and conduct research,			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
simulations and lab experiments to minimize the burden of network configurations and to visualize, gather information from and control all networked devices in the battlefield.			
Title: Tactical Information Assurance (IA) and Cyber Defense	10.442	7.180	-
Description: This effort investigates, codes and fabricates software, algorithms and devices to protect wireless tactical networks against computer network attacks. Effort includes technologies that are proactive rather than reactive in countering attacks against tactical military networks. Work being accomplished 0603794A/Project EL5 complements this effort, and is fully coordinated with the Army Research Lab Cyber Security Collaborative Research Alliance, PE 0601104A/Project EA6. In FY18 these efforts will be organized under a Cyber Electromagnetic Activity (CEMA) thrust area entitled “Cyber /CEMA Operations” in order to better focus related and evolving technology developments. ***FY 2016 Accomplishments:*** Designed and coded software that employs techniques for data sharing and collaboration between offensive and defensive operations and across security boundaries to enable advanced warning and response actions; designed and coded a software based encryptor that meets National Security Agency (NSA) formal requirements to eliminate the need for physical encryption devices; matured design of security for network protocols; researched, designed and developed algorithms to identify, protect, and prevent insider threat, negligence and-or malicious actions; researched and designed software tools and a framework for independent software assessments to easily and quickly identify vulnerabilities during development and integration with third party software to detect potential vulnerabilities well prior to the software being used on Army networks; researched, designed and coded software that incorporates cyber risk assessment, threat detection, cyber response agility and psycho-social behavior prediction to improve network security; and designed and developed an NSA Type 1 reprogrammable logic single chip cyptographic engine which includes anti-tamper and security boundary technology (both information security functions) and cryptographic engine within the chip design, emphasis was to develop a capability that can be reused, scaled, and-or repackaged to satisfy the particular constraints of different platform developments (e.g., hand held devices, unmanned sensors, satellite systems, key load devices, etc.) without significant redevelopment and recertification efforts. ***FY 2017 Plans:*** Will design models and algorithms in support of computer network defense and counter attack models; design software to address cyber risk detection, agility and human psychosocial elements as they relate to cyber defense; design, develop and validate new defensive cyber metrics; run defensive cyber operation experiments to assess tactical applicability of new cyber theories/models; make determinations on how new validated cyber theories impact other on-going cyber research and how those programs should shift their technical implementations to incorporate these theories; design a robust software solution to identify, prevent and protect role-based tactical systems from insider threats and malicious behaviors and/or negligence; design experiments for detection of insider threats based on biometric identification; identify tactical environmental roles to compare, group and generalize roles, identify system critical points and variables as part of a behavioral study, coordinate and collaborate			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*	**Project (Number/Name)** H92 / *Communications Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
with the Program Executive Offices (PEOs) and Program Managers (PMs) to gather necessary information on roles in the tactical environment; identify operational cases and insider threat scenarios, calculate risks and effects for each case type to identify solutions from commercial and government off the shelf or develop new solutions; design software and algorithms comprised of user behavioral components to identify and prevent insider, adversary and negligent action threats in existing tactical systems.			
Title: Communications Security ***Description:*** This effort researches technologies to improve the security posture of wired and wireless communications components, software and algorithms. Work being accomplished under 0603794A/ Project EL5 complements this effort. In FY18 these efforts will be organized under a new thrust area entitled “Cyber /CEMA Operations” in order to better focus related and evolving technology developments. ***FY 2017 Plans:*** Will design an advanced processing technique to reduce interference in SATCOM waveforms; design a means to monitor spectrum for wideband SATCOM and design and document situational awareness parameters, protection through diversity and interference mitigation for Army tactical SATCOM Networks; perform a detailed study to analyze wideband SATCOM interference suppression for both enterprise applications utilizing digital IF and tactical multi-frequency, time division multiple access waveform applications.	-	3.866	-
Title: Cyber/CEMA Operations ***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 awareness (SA) and situational understanding (SU) to enable effective mission planning and execution. Work being accomplished under 0603794A/Project EL5 complements this effort, and this effort is fully coordinated with the Army Research Lab Cyber Security Collaborative Research Alliance, PE 0601104A/Project EA6. Starting in FY18 efforts under “Tactical IA and Cyber Defense” and “Communications Security” are consolidated into this effort. ***FY 2018 Plans:*** Will research and design cyber security technologies to improve SA and SU of cyber threat correlated to mission impact across CEMA elements to enable actionable decisions, and enable self-defending qualities within Army networks that can absorb, deflect, evade, and deceive adverasrial cyber actions; research and conduct experiments on robust wearble 2 factor (i.e., token	-	-	7.596

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*	**Project (Number/Name)** H92 / *Communications Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
plus personal identification number) identity and network access capabilities to improve identity verification and authentication processes; research and develop anomalous behavior and insider threat detection techniques to apply to tactical radio waveforms to improve communications security against cyber threats; research and experiment with mechanisms to track data flows, monitor data modification, and ensure trusted pedigree of the information flowing across tactical networks; develop models and algorithms to reason on cyber adversary intent and predict next action; research and code intelligent algortims to efficiently pin point potentially exploitable areas within software; design and code models and techniques utilizing a software defined networking architecture to improve tactical network resilience; design and code spectrum awareness models and algorithms to detect denied spectrum conditions from jamming or other interference; and design a security architecture that supports convergence across the intelligence, network operations, cyber, electronic warfare, Fires, and information operations functions within a tactical Command Post.			
Title: Cyber Collaborative Research Alliance (CRA) ***Description:*** This effort will take innovative basic research theories from the Cyber CRA and experimentally validate the hypothesis and create proof-of-concept defensive cyber software implementations. This effort is fully coordinated with the Army Research Lab Cyber Security Collaborative Research Alliance, PE 0601104A/Project EA6. ***FY 2018 Plans:*** Will validate new defensive cyber theories in stealthy virtual machine migration, advanced persistent threat detection, malware communication detection, port scanning attack detection, and evidence collection for cyber-attacks; design models and algorithms in support of computer network defense and counter attack technologies; develop software to address cyber risk, detection, agility, and human psychosocial elements as they relate to cyber defense; develop and validate new defensive cyber metrics; run defensive cyber operation experiments to assess tactical applicability of new cyber theories/models; make determinations on how new validated cyber theories impact other on-going cyber research and how those programs should shift their technical implementations; and mature cyber theories into software capabilities that can transition into ongoing and future Cyber/CEMA Operations programs of record.	-	-	2.916
Title: Future Communications and Networking Technologies ***Description:*** This effort investigates and fabricates components and codes software for radios and network management systems to enable access to spectrum that is unavailable because of current inefficient spectrum management methods. This includes new management and visualization modalities as well as improved RF modulation techniques, devices and software. This effort investigates technologies for networking protocol development as well as networking technologies for routing and disruption tolerant networks. This effort also investigates RF signal processing, signal transmission and codes software to detect and overcome the interference of SATCOM due to jamming or atmospheric conditions. Work being accomplished under 0603794A/ Project EL4 complements this effort. In FY18 a majority of these efforts, along with several efforts currently under Antenna and	7.549	6.888	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*	**Project (Number/Name)** H92 / *Communications Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Hardware Technologies, are organized under a thrust entitled “Uninterrupted Communications” in order to better focus related and evolving technology developments. A few of the efforts herein will migrate to a new companion thrust entitled “Networking to Improve Maneuver and Expeditionary Operations. ***FY 2016 Accomplishments:*** Continued to develop and mature network and physical layer models for tactical networking waveforms to overcome RF interference; developed digital signal processing and adaptive interference cancellation algorithms to enable efficient utilization of spectrum; investigated and matured a waveform architecture to define interfaces between the various RF, networking and signal processing components; developed directional networking and disruption tolerant networks to protect the network from electronic warfare systems while using spectrum efficiently; continued to perform modeling, simulation and emulation of networks to assess network performance to quantify the efficacy of the various techniques being developed to improve the network capacity and robustness; developed network protocols for operations in contested electromagnetic environment using techniques such as interference cancellation, multifunction waveform and coordinated scheduling algorithms for electronic protection optimization; developed software defined networks for tactical applications; matured and began implementation of feasible architectures and technologies for increasing tactical network capacity and performance in a dynamic spectrum environment; developed the framework for an adaptive media access code physical layer to evolve the tactical network while improving capacity; developed resilient core and routing protocols to increase performance of the tactical network; began development of protocols to support mission and user-aware routing and content based networking; began development of networking frameworks and network abstraction layer for interoperable end to end voice over internet protocol; researched feasible approaches to enable networking in Global Positioning System denied environment; and developed security framework by investigating multi layer security routing and conduct high assurance internet protocol encryptor bypass study. ***FY 2017 Plans:*** Will develop spectrum efficient multifunctional waveforms that enable coordination of multiple command, control, communications, computing, intelligence surveillance and reconnaissance (C4ISR)/EW RF functions without cosite interference within a common RF converged chassis; mature common scheduling techniques to optimize electronic protection for tactical communication systems; implement digital RF interference cancellation algorithms for laboratory assessment; mature disruption tolerant network algorithms to make wireless networks more resilient against EW jamming while using spectrum efficiently; design and mature algorithms for forecasting and detecting anomalous network events (such as jamming, interference, congestion, network partitions) to improve network performance in a spectrum congested environment; develop a methodology to evaluate constrained application protocol management software interface to improve network management capability; design terrestrial communications waveform concept for a frequency-agile system that will support flexible resource allocation and noncontiguous channels to enable coexistence of terrestrial, SATCOM and other communications systems in congested spectrum; design standards, software, management protocols and data models for coordinated management of EW and Communications; mature			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*	**Project (Number/Name)** H92 / *Communications Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
end-to-end standard based combat voice architecture that is spectrum efficient and easy to set up and maintain; mature disruption tolerant network transport service that can provide robustness against disruptions and reliable delivery of critical data over Army tactical radio based networks; mature routing protocols and supporting framework that is mission- and user-aware to provide data delivery most efficiently in a multi-waveform environment; mature routing algorithms that support multiple network routes by coordinating multiple routing protocols for network transactions; mature software defined networking (SDN) architecture for the Army tactical edge networks and mature SDN waveforms that will identify and mitigate network vulnerabilities.			
Title: Uninterrupted Communications ***Description:*** This effort designs and matures components, software and algorithms that enable Army tactical wireless networks to provide assured uninterrupted access to critical communications and information links so that they operate more robustly in congested, contested and competitive electromagnetic environments. These capabilities will result in robust, reliable and secure terrestrial and SATCOM networks with greater survivability in austere, congested and hostile electromagnetic environments while ensuring that the capabilities are interoperable and resource efficient and will allow forces to develop SU and conduct operations to support mission command networks even under adverse operational conditions. Work accomplished under PE 0603794A/Project EL4 complements this effort. Starting in FY18 the Future Communications and Networking Technologies and Antenna and Hardware Technologies efforts are reorganized and split into this new thrust area and the new Networking to Improve Maneuver and Expeditionary Operations thrust area. ***FY 2018 Plans:*** Will conduct studies, simulations and laboratory experiments to mature low-cost integrated directional networking (DN) capability to enable operation in Global Positioning System (GPS)-denied environments; construct DN algorithms to implement adaptive antenna nulling techniques to direct emissions only in the desired direction for robust and undetectable communications while maintaining a robust tactical networking capability; conduct studies, simulations and laboratory experiments to develop efficient techniques to maintain capacity across multiple networks while providing low probability of interception (LPI) and low probability of detection (LPD) capability for individual users; and leverage techniques resulting from earlier efforts to make blue force EW and communications more interoperable and provide spectrum SA in real time to develop techniques for improved LPI/LPD while maintaining robust tactical communications.	-	-	5.266
Accomplishments/Planned Programs Subtotals	19.559	21.359	20.286

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
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D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602783A / *Computer and Software Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	12.266	13.811	14.041	-	14.041	10.074	10.276	10.482	10.692	-	-
Y10: *Computer/Info Sci Tech*	-	12.266	13.811	14.041	-	14.041	10.074	10.276	10.482	10.692	-	-

A. Mission Description and Budget Item Justification

This Program Element (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 0603008A (Command, Control, Communications Advanced Technology), PE 0603772A (Advanced Tactical Computer Science and Sensor Technology), PE 0603008A (Command, Control, Communications Advanced 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 Assistant Secretary of Defense, Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Work in this PE is performed by the Army Research Laboratory (ARL), Adelphi and Aberdeen Proving Ground, MD.

B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	12.656	13.811	14.007	-	14.007
Current President's Budget	12.266	13.811	14.041	-	14.041
Total Adjustments	-0.390	0.000	0.034	-	0.034
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.390	-			
• Adjustments to Budget Years	0.000	0.000	-0.002	-	-0.002

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army					Date: May 2017
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*		R-1 Program Element (Number/Name) PE 0602783A *I Computer and Software Technology*			
• Civ Pay Adjustments	0.000	0.000	0.036	-	0.036

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602783A / *Computer and Software Technology*	Project (Number/Name) Y10 / *Computer/Info Sci Tech*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
Y10: *Computer/Info Sci Tech*	-	12.266	13.811	14.041	-	14.041	10.074	10.276	10.482	10.692	-	-

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 Program Element (PE) 0603008A (Command, Control, Communications Advanced Technology), PE 0603772A (Advanced Tactical Computer Science and Sensor Technology), PE 0603008A (Command, Control, Communications Advanced Technology), and PE 0603794A (Command, Control and Communications Advanced Technology).

This Project supports Army Science and Technology efforts in the Command, Control, Communications, and Intelligence portfolio.

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

Work in this Project is performed by the Army Research Laboratory (ARL), Adelphi and Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Multi-Media Information Processing and Exploration	1.644	1.833	1.888
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 future force assessment.			
FY 2016 Accomplishments: Examine text analytics techniques for rapid extraction of social and cultural relationship information to increase the accuracy and timeliness of predicting attitudes for use in social network analyses; and characterize the use of crowd sourcing and teaming concepts for analysis in a DCGS-A-like environment.			
FY 2017 Plans:			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602783A / *Computer and Software Technology*	**Project (Number/Name)** Y10 / *Computer/Info Sci Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will investigate extension of social media analysis techniques to predict adversarial behaviors; and address the issues of incorporating prediction tools into a tactical local cloud computing cluster and the potential to execute these prediction tools within a tactical environment. ***FY 2018 Plans:*** Will design and develop methods to extract information from multi-source data, predict adversarial intent, and provide indications and warnings of adversarial action for use in intelligence analysis and tactical operations; investigate collective-intelligence techniques to enhance Soldier understanding of political, military, economic and social conditions in tactical environments.			
Title: Information Assurance ***Description:*** This effort develops and characterizes fusion software to improve the completeness and timeliness of decision-making for Mission Command. The focus is on software applicable to the Distributed Common Ground Station – Army (DCGS-A) architecture (an integrated architecture for intelligence systems and ground/surface command and control systems) and for future force requirements. ***FY 2016 Accomplishments:*** Examined text analytics techniques for rapid extraction of social and cultural relationship information to increase the accuracy and timeliness of predicting attitudes for use in social network analyses; and characterized the use of crowd sourcing and teaming concepts for analysis in a DCGS-A-like environment. ***FY 2017 Plans:*** Will design and characterize techniques of active cyber defense effects to disrupt adversarial command and control of heterogeneous networks while maintaining communication with key cyber terrain assets (i.e., elements of the domain that enable mission essential warfighting functions); explore and validate novel big data analytical approaches to identify and manage risks posed by emerging vulnerabilities; and develop proof-of-concept detection capabilities to identify malicious or anomalous events in a complex, interconnected information environment. ***FY 2018 Plans:*** Will design and develop methods to extract information from multi-source data, predict adversarial intent, and provide indications and warnings of adversarial action for use in intelligence analysis and tactical operations; investigate collective-intelligence techniques to enhance Soldier understanding of political, military, economic and social conditions in tactical environments.	3.452	3.944	4.050
Title: Context-Based Information Exchange ***Description:*** This effort investigates techniques that integrate local and external information sources, and it applies text and video analytic approaches to support automated intelligence analysis and decision making. The goal is to enable tactical users to cooperatively share relevant and timely tactical information within a distributed wireless environment.	1.231	2.287	2.334

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602783A / *Computer and Software Technology*	**Project (Number/Name)** Y10 / *Computer/Info Sci Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
FY 2016 Accomplishments: Explore text-based techniques, like transfer learning and semantic representation of visual concepts, as a means of overcoming challenges in extracting objects, actions, and context from video; and develop tools to assist with information extraction from various communication modes to include text embedded in video transmissions. ***FY 2017 Plans:*** Will develop quantitative models of trust and quality; explore approaches to applying user context (e.g. mission, cognitive state, trust, and quality) in networked military and social information delivery; and develop text and video analytics from research in PE 0601104A Project H50 (Network Sciences Collaborative Technology Alliance) and Project J15 (Network and Information Sciences International Technology Alliance) along with new internal ARL research and explore its effect on intelligence products. ***FY 2018 Plans:*** Will extend user context models to incorporate continuous learning to improve performance and fit of models of individual solders over time; based on context models, investigate algorithms to foresee mission-related information requirements prior to manual requests in anticipation of soldier situational awareness gaps; develop algorithms to generate computable descriptions of location imagery captured by battlefield visual sensors.			
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. ***FY 2016 Accomplishments:*** Implemented and validated advanced algorithms that improve machine translation technologies by incorporating data selection techniques into algorithms to generalize existing machine translation modules; and increased ability to translate low density languages of military interest to include key languages native to Africa. ***FY 2017 Plans:*** Will explore the use of linguistic analysis to refine the automated interpretation of cultural concepts within multi-lingual information sources; and develop and assess techniques for rapid linguistic analysis and translation of documents written in low-density languages that lack a large body of relevant previously translated texts. ***FY 2018 Plans:*** Will develop semi-supervised analysis and deep learning methods for automated information extraction from multilingual sources; develop generalized methods for the automatic processing of document images containing multilingual handwritten and	1.990	2.647	2.597

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602783A / *Computer and Software Technology*	**Project (Number/Name)** Y10 / *Computer/Info Sci Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
printed text; assess human-in-the-loop methods for leveraging semantic representations of domain data to achieve high quality translations to and from low-resource languages			
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. ***FY 2016 Accomplishments:*** Implement ultraviolet (UV) communications components that attach to the radio frequency (RF) common sensor radio; validate simulation models to investigate how mobility and autonomy may be exploited to maintain connectivity; validate that optical and UV can provide robust non-line-of- sight communications to augment RF communications; and implement mapping connectivity regions to blend with mobility planning and sensing. ***FY 2017 Plans:*** Will implement techniques for adapting communications components at the physical, media access control (MAC), and networking layers to enable robust wireless communications; develop tools for content and software based networking that enable discovery of, access to, and processing of information sources in highly dynamic and contested environments; and explore and create methodologies and approaches to increase the validity of network science experimentation results across contexts, at the appropriate network scale, and with the appropriate fidelity. ***FY 2018 Plans:*** Will develop techniques for the distributed management & control of cognitive radio networks; will implement the adaptive algorithms for robust and efficient tactical communications using cognitive and dynamic spectrum access techniques investigated and created in PE 0601102A Project H48 / Battlespace Info & Comm Rsc; explore and implement models for influencing the evolution of communication networks in spite of mobility and adversarial attacks.	1.357	1.415	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 / processing capabilities to the Soldier on the battlefield. ***FY 2016 Accomplishments:*** Designed an auto-tuning approach to balance performance models for hybrid cores where low-level instruction scheduling is a problem; implemented new mathematical algorithm to address placement of mobile high-performance computing (HPC) in	1.621	1.685	1.719

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602783A / *Computer and Software Technology*	**Project (Number/Name)** Y10 / *Computer/Info Sci Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
dynamic battlefield networks; and designed the problem for heterogeneous networks and quantify minimum communications path lengths (using quantum annealing algorithms) to converge on a solution for optimum distribution. ***FY 2017 Plans:*** Will implement auto-tuning approach to balance performance models on next generation hybrid cores where low-level instruction scheduling is a problem; validate mathematical algorithm to address placement of mobile HPC in dynamic battlefield along with other HPC systems; investigate methods for mitigating bandwidth allocation issues by utilizing emerging memory hierarchies and storage; and create algorithms to quantify resiliency for tactical HPC systems and associated programming models. ***FY 2018 Plans:*** Will design algorithm development and programming methodologies to fully utilize domain-specific processor/processing architectures (custom-engineered for size, weight and power based on task); implement middleware that enables reuse of existing code to take advantage of next generation processing capabilities; demonstrate scalability toward exascale (billion, billion calculations per second) capability of low-power next generation processing.			
Title: Material Modeling for Force Protection ***Description:*** This effort designs and characterizes software to improve parallel processing for computationally intensive physics problems. The intent is to create a computational science environment to assist researchers from different disciplines to work collaboratively and to exchange models and results. ***FY 2016 Accomplishments:*** Developed hierarchical multi-scale models for material behavior and design; used multiple parallel model couplings to tie models of different length or time scales together; investigated emerging programming languages for scalability and portability on different HPC computing platforms; and investigated applicability of emerging programming languages for the specific class of multi-physics applications related to underbody blast applications which includes modeling of the Soldier.	0.971	-	-
Accomplishments/Planned Programs Subtotals	12.266	13.811	14.041

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602783A / *Computer and Software Technology*	**Project (Number/Name)** Y10 / *Computer/Info Sci Tech*

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602784A *I Military Engineering Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	80.130	67.416	67.720	-	67.720	72.097	73.965	75.781	77.374	-	-
855: *Topographical, Image Intel & Space*	-	15.939	17.621	18.090	-	18.090	18.181	18.564	18.946	19.344	-	-
H71: *Meteorological Research For Battle Command*	-	6.351	6.476	6.628	-	6.628	5.676	5.812	5.950	6.070	-	-
T40: *Mob/Wpns Eff Tech*	-	26.196	28.142	27.955	-	27.955	32.567	33.768	34.556	35.290	-	-
T41: *Mil Facilities Eng Tec*	-	5.732	6.216	6.457	-	6.457	6.506	6.625	6.758	6.899	-	-
T42: *Terrestrial Science Applied Research*	-	5.120	5.152	5.120	-	5.120	5.167	5.277	5.417	5.534	-	-
T45: *Energy Tec Apl Mil Fac*	-	3.292	3.809	3.470	-	3.470	4.000	3.919	4.154	4.237	-	-
T53: *Military Engineering Applied Research (CA)*	-	17.500	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

This Program Element (PE) investigates and advances technologies, techniques, and tools for representation of the physical and human environment for use in military planning and operations; for characterizing geospatial, atmospheric, and weather conditions and impacts on systems and military missions; for conducting mobility, counter-mobility, survivability, and force protection planning and operations; and for enabling secure, sustainable, energy efficient facilities. Research focuses on special requirements for battlefield visualization, tactical decision aids, weather intelligence products, and capabilities to exploit space assets. Project 855 conducts geospatial research and development supporting a standard sharable geospatial foundation enabling a common operating environment across mission and command systems. Project H71 supports the materiel development, testing, and operations communities in evaluating the impacts of weather and atmospheric obscurants on military materiel and operations. Project T40 advances force protection technologies across the range of military operations, including expedient protection and hardened construction to defeat complex threats. This Project also designs and evaluates 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 evaluates materiel solutions, including rapidly emplace bridging and expedient repair technologies, to allow austere port and airfield entry of forces; and builds and uses modeling and simulation tools to advance understanding of the interactions of weapons/munitions and novel defeat methodologies with buildings, shelters, bunkers, berms, and bridges. 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 evaluate 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 and evaluates 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 cited work is consistent with the Assistant Secretary of Defense, Research Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Research is transitioned to PE 0603734A (Military Engineering Advanced Technology).

Work in this PE is led, managed, or performed by the Army Engineer Research and Development Center, Vicksburg, MS, and the Army Research Laboratory, Aberdeen Proving Ground, MD.

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	80.909	67.416	70.683	-	70.683
Current President's Budget	80.130	67.416	67.720	-	67.720
Total Adjustments	-0.779	0.000	-2.963	-	-2.963
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.779	-			
• Adjustments to Budget Years	0.000	0.000	-3.250	-	-3.250
• Civ Pay Adjustments	0.000	0.000	0.287	-	0.287

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2016	FY 2017
Project: T53: *Military Engineering Applied Research (CA)*		
Congressional Add: *Program Increase*	17.500	-
Congressional Add Subtotals for Project: T53	17.500	-
Congressional Add Totals for all Projects	17.500	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / *Military Engineering Technology*	Project (Number/Name) 855 / *Topographical, Image Intel & Space*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
855: *Topographical, Image Intel & Space*	-	15.939	17.621	18.090	-	18.090	18.181	18.564	18.946	19.344	-	-

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.

Work in this Project complements efforts in Program Element (PE) 0602784A, Project H71.

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

The work in this Project is performed by the Army Engineer Research and Development Center, Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Terrain Analysis for Signal and Sensor Phenomenology	2.223	-	-
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 methods for radical, effective sensor systems and materials to 'tag' features, items, and people of interest; these capabilities are based upon novel and emerging light detection and ranging (LiDAR) sensor systems and an array of other sensor systems for intermittent and persistent optimal data collection, object identification, and classification for ground operations. Elements of this effort develop further in GeoIntelligence - Terrestrial Remote Sensing and Data Visualization in Fiscal Year (FY) 2017.			
FY 2016 Accomplishments:			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** 855 / *Topographical, Image Intel & Space*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Developed initial algorithms to exploit three-dimensional (3D) terrain data using hyper-spectral data sources; analyzed existing algorithms for tactical terrestrial remote sensing capabilities to enhance geospatial 3D data for expanded awareness in the area of interest (AOI).			
Title: Imagery and GeoData Sciences ***Description:*** This effort advances map creation and content through both conventional and non-traditional methods. This research exploits existing open source text, leverages multi-media and cartographic materials, and investigates data collection methods to ingest geospatial data directly from soldiers (i.e., crowd sourcing) 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 dimension which offers a holistic view of the operational environment for the Warfighters. Elements of this effort develop further in Map-Based Planning Services (MBPS), and Human Geography - Spatial Reasoning, Analysis, and Visualization in FY17. ***FY 2016 Accomplishments:*** Investigated and developed geospatial analysis tools leveraging authoritative Department of Defense (DoD) databases to support military planning; developed methods to efficiently query databases in multiple Computing Environments to produce geospatial overlays depicting elements of sociocultural behavior; conducted research methods allowing Army planners to exploit the Standard, Shareable, Geospatial Foundation (SSGF) data and services to provide a common geospatial framework for commanders and their staff.	4.915	-	-
Title: Geospatial Reasoning ***Description:*** This effort develops and evaluates software analysis tools and methods to provide impact and context of the effects of the physical terrain, human terrain, and environmental conditions on military operations. This analysis examines and models these effects upon unit tactics, equipment, and Soldiers' performance. Elements of this effort develop further in GeoIntelligence - Terrestrial Remote Sensing and Data Visualization, GeoIntelligence – Geospatial Data Generation and Decision Support, and Army Terrestrial Environmental Modeling & Intelligence System (ARTEMIS) in FY17. ***FY 2016 Accomplishments:*** Developed methods to deliver and integrate novel geospatial products using open standards and formats into the AGE. Began research on information fusion to evaluate accuracy and relevance of dynamic terrain information layers that support the military decision making process; initiated methods to leverage and develop open source LiDAR processing capabilities to enhance feature classification and sensor exploitation. Developed stand-off soil moisture assessments and comparisons to further assist	6.014	-	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** 855 / *Topographical, Image Intel & Space*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
real-time mapping of moisture levels, assisting in mobility forecasts. Began research on information fusion to evaluate accuracy and relevance of dynamic terrain information layers that support the military decision making process.			
Title: Geospatial and Temporal Information Structure and Framework ***Description:*** This effort designs and evaluates geospatial data and information architecture to ensure content and representation of data and actionable geospatial information for operational decision making. Research advances here allow for the automatic inference and correlation between events and objects (i.e., people, places) through space and time from massive datasets. Success in meeting these objectives advances the Army's ability to network the force to achieve information dominance. Elements of this effort develop further as GeoIntelligence - Geospatial Data Generation and Decision Support, and Human Geography - Spatial Reasoning, Analysis, and Visualization in FY17. ***FY 2016 Accomplishments:*** Developed data mining algorithms to support discovery of relevant information and patterns contained within large, multi-modal, and multi-scale spatially and temporally referenced datasets; explored new exploitation techniques and algorithms to characterize the urban operational environment and develop geospatial products focused on hazardous terrain identification; enhanced the capability to capture and visualize dynamic spatiotemporal narratives that describe relationships of people, events, and geographic locations through time; developed the capability to characterize the relationship between environment and conflict through systems models that demonstrate the impacts of environmental conditions on stability. Developed algorithms to incorporate sociocultural factors and data for more effective analysis of violent events.	2.787	-	-
Title: GeoIntelligence - Geospatial Data Generation and Decision Support ***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 Geospatial and Temporal Information Structure and Framework 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. This item continues efforts from Geospatial Reasoning, and Geospatial and Temporal Information Structure and Framework. ***FY 2017 Plans:*** Will complete development of a new algorithm suite to enable rapid processing and searching of high volume multi-modal spatiotemporal datasets for revealing and illuminating relevant embedded relationships, spatiotemporal threads, and discoverable meaningful patterns associated with human geography (e.g., actors, places, events, and time); research new terrain analytics and tactical decision aids supporting Warfighter tactical operations in 3D dense urban terrain environments by providing hazard	-	4.940	2.489

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** 855 / *Topographical, Image Intel & Space*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
identification and mitigation, remote feature classification, and 3D terrain analysis techniques; and develop rapid tools for characterization of hazardous urban terrain effects, the detection and identification of urban and peri-urban feature classes using remotely sensed data, and input layers for geospatial analytics enabling multi-source, urban-relevant data enterprise integration. ***FY 2018 Plans:*** Will investigate advanced analytical and streaming methods for geo-registering and provisioning critical infrastructure symbology to system displays supporting mounted and dismounted Warfighter situation awareness.			
Title: GeoIntelligence - Terrestrial Remote Sensing and Data Visualization ***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 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. This item continues efforts from Terrain Analysis for Signal and Sensor Phenomenology, and Geospatial Reasoning. ***FY 2017 Plans:*** Will conduct research on terrain feature extraction important to mission planning to provide the terrain and image analyst access to surface roughness, vegetation density, characterization of built-up areas, and near ground obstacles; investigate laser detection and ranging (LADAR) sensors for base force protection through physical mounting integration, mast stabilization optimization, and software techniques enabling anomaly detection, change assessment, and sensor cueing capabilities. ***FY 2018 Plans:*** Will investigate new capabilities to characterize and extract (identify and map) features of interest under forest canopies such as encampments, small buildings, trails, etc. at high fidelity; develop algorithms and workflows to generate critical and accurate mapping data for units at the tactical level; and integrate frequency-modulated, continuous wave (FMCW) laser scanner into base security and defense sensor suite for 3D terrain rendition and persistent surveillance and target identification.	-	4.462	4.991
Title: Human Geography - Spatial Reasoning, Analysis, and Visualization ***Description:*** This effort investigates integration of behavior and population dynamics research and analysis into geospatial frameworks to depict the operational environment including culture, demographics, terrain, climate, and infrastructure. Research exploits existing open source text, leverages multi-media and cartographic materials, and investigates data collection methods to ingest geospatial data directly from the tactical edge to characterize parameters of social, cultural, and economic geography.	-	2.007	4.013

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** 855 / *Topographical, Image Intel & Space*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
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. This item continues efforts from Imagery and GeoData Sciences, and Geospatial and Temporal Information Structure and Framework and complements the work in PE 0602784A/Project T41. ***FY 2017 Plans:*** Will research and design a framework to investigate the impacts of environmental stressors (e.g. water security) on populations and military operations. ***FY 2018 Plans:*** Will investigate means for a repeatable methodology to incorporate social-cultural influences (e.g., civil considerations) into the military decision making process by identifying the critical conduits through which actors exercise power; and research existing authoritative data sources and potential new sources for factoring environmental and climate-related risks into long range military planning scenarios supporting theater engagement plans.			
Title: Weather and Terrain Integration ***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. This item continues efforts from Geospatial Reasoning. ***FY 2017 Plans:*** Will complete uncertainty and sensitivity analysis of stand-off soil moisture assessments and comparisons to further mature real-time mapping of moisture levels and develop improved tactical mobility forecasts; and investigate new visibility algorithms based on dust, aerosol, and humidity fields for line of sight representation in a Situationally Aware Geospatially Enabled (SAGE) terrain analysis decision aid. ***FY 2018 Plans:*** Will investigate a risk-based, geospatially grounded decision support tool using multi-criteria decision analysis to facilitate a modeling environment that enables risk-informed mission decisions based on criteria including time available, physical distance, terrain or infrastructure requirement, and acceptable mission risk; and provide analytical tools that seamlessly integrate changes in the physical battlespace in near-real time with terrain based tactical decision aids, such as mounted and dismounted mobility, line of sight, and potential choke points.	-	2.455	2.599
Title: Map-Based Planning Services (MBPS)	-	3.757	3.998

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** 855 / *Topographical, Image Intel & Space*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
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. This item continues efforts from Imagery and GeoData Sciences. Resultant work products proceed into Program Element 0603734A, Project T08. ***FY 2017 Plans:*** Will develop approaches to enable Army planners at multiple echelons and at distributed locations to exploit a common geospatial framework within the planner enclave for concurrent planning; and investigate migration of planners' tools and services to a web-based capability ***FY 2018 Plans:*** Will develop a geospatially enabled collaborative mission planning environment that provides services, authoritative data access, and information to distributed Army planners, staffs, and leaders, to enable the collection, processing, storing, displaying, and sharing of authoritative data/information in a geo-temporal context; and investigate adaptation of existing and developed intelligence preparation of the battlefield and military decision making process capabilities into the digital planning process.			
Accomplishments/Planned Programs Subtotals	15.939	17.621	18.090

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / *Military Engineering Technology*	Project (Number/Name) H71 / *Meteorological Research For Battle Command*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
H71: *Meteorological Research For Battle Command*	-	6.351	6.476	6.628	-	6.628	5.676	5.812	5.950	6.070	-	-

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.

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

This work transitions technologies to the Department of Defense weather and operations modeling community, the US 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).

Work in this Project is performed by the Army Research Laboratory located at Adelphi, MD and White Sands Missile Range, NM.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Atmospheric Characterization, Modeling, and Impacts (formerly Atmospheric Modeling)	2.443	5.126	5.622
Description: This effort develops high resolution, short-range forecasting, and high resolution atmospheric modeling capabilities for mountainous, urban, and forest complex terrain. ***FY 2016 Accomplishments:*** Completed “Weather Running Estimate-Nowcast” (WRE-N) tool accuracy assessments with applications to Army aviation, artillery, and dismounted operations; evaluated potential improvements to artillery firings by implementing three-dimensional forecast datasets into targeting solutions; developed a method in WRE-N that combines four-dimensional data assimilation and variational data assimilation methods to ingest remotely sensed indirect weather observations such as radar / light detection and			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** H71 / *Meteorological Research For Battle Command*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
ranging (LiDAR), global positional system (GPS) techniques, and satellite imagery or radiances; extended WRE-N's grid spacing resolution to hundreds of meters; and developed a method to assimilate Doppler wind LiDAR data into the microscale model for more accurate predictions of wind fields in the atmospheric boundary layer over complex terrain. ***FY 2017 Plans:*** Will refine and mature Meteorological Sensor Array (MSA) computer applications that provide non-standard sensing capabilities for the atmospheric boundary layer, including novel employment of weather sensing small unmanned aircraft systems (UAS) vehicles; develop MSA systems at multiple sites to study atmospheric characteristics in different microclimate/terrain regimes; conduct research to quantify climate and weather impacts on the design and deployment of renewable energy systems that are operationally relevant to the Army; conduct research, analysis, and software development to quantify the effects of weather on systems and operations; complete initial studies addressing integration of probabilistic and uncertainty forecasts into decision support tools (DSTs); fully-integrate various sources of observational data into the forecast model assessment processes, utilizing Geographic Information System-based and other advanced assessment techniques; fully evaluate the benefits of assimilated Doppler wind LIDAR data into microscale models to improve predictions of winds in the atmospheric boundary layer over complex terrain; conduct initial capability studies addressing high-resolution atmospheric model performance as related to sensor performance; conduct applied research to better characterize the impact of airborne aerosols on electro-optical propagation; apply appropriate techniques to the mitigation of atmospheric turbulence on the propagation of electro-optical signals; and improve the performance of DSTs for acoustics propagation and characterizing the state of the atmosphere. ***FY 2018 Plans:*** Will fully adapt a hybrid assimilation methodology by which meteorological data types representative of battlefield conditions may be ingested into numerical weather prediction models for enhanced forecast accuracy; demonstrate the efficacy of Geographic Information System (GIS) analytical techniques for forecast model accuracy assessments; apply intuitive, qualitative indicators of forecast confidence to meteorological data output and weather impacts displays; establish quantified performance criteria for an optical imaging system that mitigates image degradation due to atmospheric optical turbulence; enhance capabilities of route optimization tactical decision aid to minimize aircraft acoustic signatures and to account for soil type and terrain steepness affecting ground vehicle mobility and maneuver; and, implement parallel processing architectures in Personal Electronic Devices (PEDs) to allow mobile execution of weather forecast models; develop initial forward-deployed capability to integrate atmospheric prediction/weather decision aid applications into unified environmental awareness system supporting robotics and autonomous systems; and refine atmospheric acoustic signal propagation models with data collected at the MSA..			
Title: Atmospheric Diagnostics ***Description:*** This effort develops diagnostic technologies and methods to improve the acquisition of environmental data such as temperature, humidity, wind speed and direction for use in decision aids that enhance and protect autonomous and semi-	2.014	-	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** H71 / *Meteorological Research For Battle Command*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
autonomous systems. Work in this task is consolidated under Task 02, Atmospheric Characterization, Modeling, and Impacts, beginning in Fiscal Year (FY) 17. ***FY 2016 Accomplishments:*** Designed and developed MSA components that provide, non-standard sensing capabilities for the atmospheric boundary layer; investigated developing an array at an alternate site in order to study atmospheric characteristics in different climatic/ terrain regimes; and developed automated approaches to quality control, archiving, and ingest to microscale meteorological and turbulence models of MSA array data.			
Title: Local Area Atmospheric Prediction for Geospatial Applications (formerly Atmospheric Prediction for Local Areas) ***Description:*** This effort designs and evaluates 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. ***FY 2016 Accomplishments:*** Prepared the Atmospheric Boundary Layer Environments (ABLE) microscale model for transition into the DCGS-A architecture; researched and developed an initial capability to ingest and depict probabilistic forecast data into DCGS-A weather impacts DSTs; and matured automated algorithms and methods for the microscale model initial and boundary conditions using data from WRE-N mesoscale model results. The microscale and WRE-N nowcasting model results (rapidly updated local short-term predictions) were integrated with weather decision support tools for mission planning and execution ***FY 2017 Plans:*** Will conduct very fine-scale nowcast modeling research using the Weather Research and Forecasting (WRF) model, the WRF coupled with atmospheric chemistry (WRF-Chem) model, and other appropriate models to address dust lofting and model coupling to terrain/trafficability models; complete model resolution tests of acoustic sensor performance to determine optimized model configurations and resolutions for operational use; configure and complete acoustic sensor/atmospheric modeling field experiments to validate the model resolution conclusions; and design and complete sub-kilometer atmospheric modeling studies linking land surface models with WRF to improve soil strength and terrain trafficability models. ***FY 2018 Plans:*** Will conduct acoustic sensor/atmospheric modeling field experiments to validate model resolution results; assess validity of foundation model for use in elevated dust events; and deliver sub-kilometer model configuration options to effectively link coupled land-surface and atmospheric models for improved vehicle trafficability and routing models.	1.894	1.350	1.006
Accomplishments/Planned Programs Subtotals	6.351	6.476	6.628

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** H71 / *Meteorological Research For Battle Command*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / *Military Engineering Technology*	Project (Number/Name) T40 / *Mob/Wpns Eff Tech*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
T40: *Mob/Wpns Eff Tech*	-	26.196	28.142	27.955	-	27.955	32.567	33.768	34.556	35.290	-	-

A. Mission Description and Budget Item Justification

This Project investigates, evaluates, and develops technologies for adaptive and expedient force protection 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; 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 survivability of critical assets from conventional, unconventional, and emerging threats and enables maneuver support of deployed forces, while reducing their logistical footprint. This Project supports efforts for overcoming critical capability gaps for protecting troops operating in a number of environments, including smaller bases that are remote or integrated with local communities, and dismounted Soldiers conducting missions in urban environments.

Work in this Project supports the Army Science and Technology Ground Maneuver, Command, Control, Communications, and Intelligence (C3I), Innovation Enablers, and Soldier Portfolios.

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

This work is fully coordinated with and complementary to Program Element (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 / 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 0603639A (Weapons and Munitions - Advanced Development) / EC3 (Ammunition Logistics Prototyping), and 0605805A (Munitions Standardization, Effectiveness and Safety) / Project 297 (Mun Survivability & Log).

Work in this Project is performed by the Army Engineer Research and Development Center, Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Adaptive Protection	10.395	11.173	10.988
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			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T40 / *Mob/Wpns Eff Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
small bases and soldiers in complex and urban environments; techniques to protect, conceal, or deter against advanced threats including missiles; and techniques to identify tunnels and subterranean activities. ***FY 2016 Accomplishments:*** Developed rapidly emplaced force protection technologies and survivability and planning tools to decrease required Soldiers needed for construction of Combat Outpost or Patrol Base (COP/PB). Developed force protection technologies to mitigate lethality of advanced threats in order to increase survivability of personnel, critical assets, and fixed facilities. Developed and improved modeling and simulation (M&S) capabilities to rapidly and comprehensively model the blast from a wide range of recent and emerging non-ideal homemade explosives (HME) in a variety of soil types and conditions. ***FY 2017 Plans:*** Will conduct experiments to determine the blast and penetration performance of cast-in-place protective structural components made with indigenous materials. Will develop geophysical linear sensor systems in support of tactical security systems. Will increase and refine blast prediction M&S capabilities of HMEs and expand soil and condition databases. Will develop technologies to detect tunnels and subterranean activities for protection of forces and critical assets. ***FY 2018 Plans:*** Will develop M&S tools to predict structural response/damage to support regional tradespace analysis; develop and improve the adaptive capabilities to rapidly and comprehensively model the blast from a wide-range of recent and emerging non-ideal HMEs in a variety of soil types and conditions; develop materials and advanced force protection decision support tools for use in complex and dense urban environments; develop advanced integrated camouflage, concealment, and deception (CCD) methods and materials to protect against advanced threat; and develop technologies to more accurately detect tunnels for protection of small distributed units.			
Title: Austere Entry and Maneuver ***Description:*** This effort investigates, designs, and creates tools and technologies that identify, assess, and monitor structural and functional suitability of theater access points and infrastructure, allow planning of tactical logistics resupply networks that enable planners to develop and compare courses of action, and simulate manned/unmanned tactical maneuver and mobility of small units in complex and urban terrains. This effort is coordinated with Program Element 0603005A. ***FY 2016 Accomplishments:*** Developed computational test bed applications to simulate the influence of dynamic environmental effects created by vehicles and humans on sensor-based perception. Completed modeling of dismounted operations and continued to develop the distribution management tool and provide systems integration to simulate the entire logistics distribution network. Completed development of	12.607	12.766	11.956

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T40 / *Mob/Wpns Eff Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
the capability to numerically simulate infrasonic sources for regional assessment of infrastructures. Refined sensor evaluation of airports and seaports of debarkation and reduced order modeling for austere entry assessment. ***FY 2017 Plans:*** Will continue development of dynamic environmental vehicle simulation tools to support autonomous ground resupply operations. Will complete development of a planning tool for comparing early entry alternative courses of action for a logistics distribution network. Will continue refinement of remote and standoff assessment techniques for airports and seaports of debarkation for austere entry assessment. Will begin an effort to predict vehicle movement in complex and urban environments. ***FY 2018 Plans:*** Will complete development of technologies for planning and conducting Anti-Access/Area Denial (A2/AD) entry operations without airfields/ports and with damaged/destroyed airfields/ports; develop a fused multi-component imagery and infrasound data method for persistent critical infrastructure modeling in dynamic environments; and develop baseline model and simulation tools for autonomous ground resupply operations and will continue development of mobility decision support tools.			
Title: Environmental Impacts on Sensor Performance ***Description:*** This effort investigates, designs, and creates physics-based, multiscale numerical models of the geo-environment and synthetic environments representing geo-environment impacts on various sensor modalities and systems. These enable the development of sensors and sensor algorithms for object or target detection, sensor-target pairing, 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. ***FY 2016 Accomplishments:*** Developed high performance computing (HPC)-enabled models that simulate the geo-environmental impact on performance of multi-modal imaging sensor combinations for threat scenarios. Developed three-dimensional, integrated surface evaporation/condensation algorithms for ground and vegetated surfaces and validate with ground truth characterization of the hydrodynamic and thermal processes in dense rainforest environments. ***FY 2017 Plans:*** Will integrate HPC-enabled models with Night Vision and Electronic Sensors Directorate's hyperspectral sensors to simulate the geo-environmental impact on performance of multi-modal imaging sensor combinations for threat scenarios. Will continue development of advanced analytic tools to determine detection performance of multi-modal and spectral sensor combinations. ***FY 2018 Plans:***	1.976	2.965	3.745

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T40 / *Mob/Wpns Eff Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will complete development of HPC-enabled models and advanced analytic tools combined in a simulation workflow manager; and investigate fusion of multi-sensor performance predictions and use of a tradespace framework to compare performance, cost, and availability for specific geo-environmental settings.			
Title: Materials Modeling ***Description:*** This effort investigates and leverages physics-based computational models and laboratory experiments to understand the relationships between the chemical and micro-structural composition of materials and their performance characteristics when used in protecting facilities. ***FY 2016 Accomplishments:*** Enhanced materials by design of cementitious and polymer composite protective materials through the continued development and validation of multi-scale predictive design tools; developed methods to control bonds between reinforcement and cementitious matrices at multiple scales to optimize composite performance; integrated novel processing and additive manufacturing methodologies into material system design and fabrication methods to support the maturation of advanced protective solutions. ***FY 2017 Plans:*** Will continue to develop and validate multi-scale high performance protective materials, predictive design tools, and material models; will continue to develop methods to predict constituent material properties of cementitious and polymeric materials at multiple scales to optimize performance; will continue to integrate novel processing and additive manufacturing methodologies into material system design and fabrication methods to support the maturation of advanced protective solutions; these efforts support the development of the next generation of high performance materials for force and critical asset protection against advanced threats. ***FY 2018 Plans:*** Will develop and validate advanced protective material solutions including novel composites, lightweight metals, ceramics, coatings, polymers, and other non-cementitious materials; continue virtual material by design development and advanced mico- and meso-scale simulations to predict engineering properties in the resultant macro-scale materials; and investigate material fabrication and manufacturing methods for layered protective systems.	1.218	1.238	1.266
Accomplishments/Planned Programs Subtotals	26.196	28.142	27.955

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T40 / *Mob/Wpns Eff Tech*

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / *Military Engineering Technology*	Project (Number/Name) T41 / *Mil Facilities Eng Tec*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
T41: *Mil Facilities Eng Tec*	-	5.732	6.216	6.457	-	6.457	6.506	6.625	6.758	6.899	-	-

A. Mission Description and Budget Item Justification

This Project investigates and evaluates technologies and techniques to ensure sustainable, cost efficient, and effective facilities, and to achieve resilient and sustainable installation and base operations. The project focuses on facilities and operations technologies directly supporting training, readiness, force projection, force protection, homeland security, and forward base operations. 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 ability of 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 forward bases, 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 forward base operations, including urban environments.

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

Work in this Project is performed by the Army Engineer Research and Development Center, Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Adaptive and Resilient Installations	3.062	3.620	3.806
Description: This effort develops technologies and techniques to enable sustainable, cost efficient, and effective facilities; and provides technologies and techniques for achieving resilient and sustainable installation and base operations.			
FY 2016 Accomplishments: Researched the necessary mixture design and admixtures requisite to allow additive construction using cementitious materials across the broadest possible locations and operating environments. Determined the correct formulations to adapt locally available cementitious materials to required rheology, curing time, and strength for automated additive construction of expeditionary structures. Determined the serviceability of other native materials (such as soils, clay, and sand mixtures like adobe) for use as extrudable building materials.			
FY 2017 Plans: Will develop a suite of physics-based models and simulations to perform structural, energy, and protection analysis of digital designs used for automated construction of expeditionary structures. Will conduct simulations to generate tradespace analyses			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T41 / *Mil Facilities Eng Tec*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
for prototype model development. Will develop a prototype tool to assess the impact of physical, ecological, and sociocultural environments relative to contingency base site selection, design, operations, and maintenance to support operational planning. ***FY 2018 Plans:*** Will investigate potential impacts to contingency basing operational effectiveness due to location, duration, size (area and population), effects on sociocultural context, and changes in mission; and investigate and design a systematic approach to identify and model current and future permafrost and ground ice impacts on built infrastructure, operational training, and deployment design considerations in arctic and sub-arctic environments.			
Title: Human Geography – Fundamentals of Behavior and Population Dynamics (Previously titled Social/Cultural Behavior) ***Description:*** This effort researches population dynamics including physical, cultural, psychological, and behavioral attributes critical to U.S. 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. This effort complements the work in Program Element 0602784A (Military Engineering Technology) / Project 855 (Topographical, Image Intel & Space). ***FY 2016 Accomplishments:*** Investigated capability to integrate existing information about population and knowledge of the theater environment into urban condition monitoring capabilities and drive assessment of strengths and deficiencies of host-nation areas; developed methods to produce composite geospatial products from multiple human and environmental data inputs and semi-automated analytic tools; investigated approaches to display socio-cultural data markers in spatial-temporal views for the Warfighter to incorporate into Military Decision Making Process (MDMP) and Troop Leading Procedures (TLP) products. ***FY 2017 Plans:*** Will investigate and design a framework for integrating social-cultural dynamics (human aspects of the operational environment) encountered in dense urban environments into mission planning and execution.. ***FY 2018 Plans:*** Will investigate methods for military assessment of population vulnerability and resilience disruptors as a result of combat, disasters, disease, etc., within dense urban and complex environments; and research computational models to support a federated model approach for complex urban systems; and develop methodologies to support the military decision making process addressing the impacts of the physical, ecological, and sociocultural environments relative to contingency base site selection, design, operations and maintenance.	2.670	2.596	2.651
Accomplishments/Planned Programs Subtotals	5.732	6.216	6.457

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T41 / *Mil Facilities Eng Tec*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / *Military Engineering Technology*	Project (Number/Name) T42 / *Terrestrial Science Applied Research*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
T42: *Terrestrial Science Applied Research*	-	5.120	5.152	5.120	-	5.120	5.167	5.277	5.417	5.534	-	-

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.

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

Work in this Project is performed by the Army Engineer Research and Development Center, Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Analysis for Signal & Signature Phenomenology	1.646	-	-
Description: This effort investigates the dynamics of electromagnetic, acoustic, and seismic signatures in response to changing terrain state and complex terrain features and geometry. Research results improve sensor employment tactics, techniques, and procedures, and numerical modeling of terrain properties for tactical advantage and geospatial tactical decision aids. This work continues as GeoIntelligence - Terrestrial Phenomenology Characterization for Geospatial Applications. ***FY 2016 Accomplishments:*** Investigated methods and advanced tools for storing, indexing, and managing raw light detection and ranging (LiDAR) sensor data in a geospatial database enabling immediate remote processing and exploitation for tactical terrain analysis; developed techniques for fusing disparate data sources and types (e.g. point clouds and imagery) by retaining all critical collection attributes, thus providing significant military utility of terrain information and features for high fidelity mission planning and execution.			
Title: Army Terrestrial Environmental Modeling & Intelligence System (ARTEMIS)	3.474	3.500	3.619

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T42 / *Terrestrial Science Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
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. ***FY 2016 Accomplishments:*** Initiated development of digital product layers that reflect land-atmosphere impacts on mobility, austere entry, and sensor performance and research risk-based analysis of terrestrial processes on military operations. Initiated evaluation of acoustic, seismic, and radiofrequency (RF) modeling complexities in complex urban and terrain environments where signals are impacted by scattering objects. Conducted research of time-sensitive activity within the soil as shaped by dynamic soil descriptors to support enhanced predictive analysis of soil-weather-terrain governed maneuver and sensor constraints. Investigated remote and automated analysis methods for identifying and locating areas suitable for aircraft landing or drop zones. ***FY 2017 Plans:*** Will complete development of remote assessment of landing zones and drop zones capability for Intelligence Preparation of the Battlefield products; integrate and validate the utility of high resolution weather data in signal propagation prediction software; complete initial development of a fused and synchronized dynamic geospatial framework for understanding, through risk-based applications, the effect of weather-impacted terrestrial processes on military operations at all echelons. ***FY 2018 Plans:*** Will mature a dynamic, coupled land-atmosphere modeling and simulation capability to inform military mission planning by providing fused all-weather and all-season tactical decision aids, delivering risk-based assessments for mission specific terrain analysis, tactical movement and maneuver, and sensor planning.			
Title: GeoIntelligence - Terrestrial Phenomenology Characterization for Geospatial Applications (Formerly Analysis for Signal & Signature Phenomenology)	-	1.652	1.501
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.			
FY 2017 Plans:			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T42 / *Terrestrial Science Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will research web-based three-dimensional (3D) visualization of tactical decision aids to enhance point cloud analytics in bandwidth limited environments and mobile applications; investigate utility of LiDAR and terrain based 3D products through new algorithms and processes to access and reuse level zero (raw) data collections preserving sensor calibration and error meta-data. ***FY 2018 Plans:*** Will develop algorithms for rapidly indexing and provisioning very large LiDAR point cloud collections, greatly simplifying the analyst's access to 3D terrain data; and mature new web based 3D point cloud visualization and analysis capability greatly extending the data utility to the terrain analyst and image analyst.			
Accomplishments/Planned Programs Subtotals	5.120	5.152	5.120

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / *Military Engineering Technology*	Project (Number/Name) T45 / *Energy Tec Apl Mil Fac*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
T45: *Energy Tec Apl Mil Fac*	-	3.292	3.809	3.470	-	3.470	4.000	3.919	4.154	4.237	-	-

A. Mission Description and Budget Item Justification

This Project investigates and evaluates technologies necessary for secure, efficient, sustainable military installations and contingency bases, emphasizing facility systems protection in response to evolving needs. 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 protect facility indoor air quality from contaminants such as mold, bacteria, and viruses in work and living spaces, as well as develops methods to optimize sustainable operations and maintenance to minimize lifecycle costs. 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.

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

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

Work in this Project is performed by the Army Engineer Research and Development Center, Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Adaptive and Resilient Installations	3.292	3.809	3.470
Description: This effort investigates and develops technologies necessary for energy efficient and sustainable military installations, emphasizing energy and utility systems.			
FY 2016 Accomplishments: Investigated the impacts on energy efficiency and lifecycle sustainability of contingency basing structures constructed with cementitious materials assembled via an additive process for construction. Investigated the impacts on construction geometries of the structures along with the physical attributes of the supporting pad, walls, and ceiling. Evaluated material mixtures and additives, as well as nozzle shapes and combinations, to allow complex wall configurations for improvement of thermal characteristics while maintaining structural integrity.			
FY 2017 Plans:			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T45 / *Energy Tec Apl Mil Fac*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will validate simulations for a prototype automated construction capability for expeditionary structures and assess modified designs to allow for improved thermal characteristics and structural integrity. Will investigate methods for rapid and automated acquisition of existing facility information in remote environments. ***FY 2018 Plans:*** Will develop a tool for efficient siting of contingency bases, informing real estate decisions made between the United States (U.S.) and a host nation during Phase Zero operations to inform military planners of potential impacts to operational effectiveness due to location, duration, size (area and population), effects on sociocultural context, and changes in mission; and assess the relative risk associated with contingency construction activities and investigate risk mitigation frameworks through the employment of autonomous construction methods.			
Accomplishments/Planned Programs Subtotals	3.292	3.809	3.470

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / *Military Engineering Technology*	Project (Number/Name) T53 / *Military Engineering Applied Research (CA)*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
T53: *Military Engineering Applied Research (CA)*	-	17.500	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

Note

Not applicable for this item

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Military Engineering applied research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017
Congressional Add: Program Increase	17.500	-
FY 2016 Accomplishments: Program increase for military engineering applied research		
Congressional Adds Subtotals	17.500	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602785A / *Manpower/Personnel/Training Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	22.474	26.045	20.216	-	20.216	21.902	23.691	24.090	25.909	-	-
790: *Personnel Performance & Training Technology*	-	22.474	26.045	20.216	-	20.216	21.902	23.691	24.090	25.909	-	-

A. Mission Description and Budget Item Justification

This Program Element (PE) conducts applied behavioral and social science research to enhance the Soldier Lifecycle (e.g., selection, assignment, training, leader development) and human relations (e.g., culture of dignity, respect, and inclusion). These technologies provide advanced personnel measures that more fully assess potential and predict performance, behavior, attitudes, and resilience. These technologies also provide innovative and effective training and mentoring methods to ensure Soldiers, leaders, and units have the knowledge, skills, and abilities to sustain positive unit climates and meet mission requirements in uncertain and complex environments. This PE evaluates new selection measures, refines performance metrics, assesses 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.

Efforts in this PE support the Army Science and Technology Soldier portfolio.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Human Capital Strategy.

Work in this PE is performed by the Army Research Institute (ARI) for the Behavioral and Social Sciences in Ft. Belvoir, VA.

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	24.735	26.045	24.910	-	24.910
Current President's Budget	22.474	26.045	20.216	-	20.216
Total Adjustments	-2.261	0.000	-4.694	-	-4.694
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-1.700	-			
• SBIR/STTR Transfer	-0.561	-			
• Adjustments to Budget Years	0.000	0.000	-4.694	-	-4.694

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army	Date: May 2017
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602785A / *Manpower/Personnel/Training Technology*

Change Summary Explanation

Fiscal Year (FY) 2018 funding reduction reflects realignment of Army Research Institute manpower from PE 0602785A to PE 0605898A, Project XW7.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602785A / *Manpower/Personnel/ Training Technology*	Project (Number/Name) 790 / *Personnel Performance & Training Technology*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
790: *Personnel Performance & Training Technology*	-	22.474	26.045	20.216	-	20.216	21.902	23.691	24.090	25.909	-	-

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., culture of dignity, respect, and inclusion). These technologies provide advanced personnel measures that more fully assess potential and predict performance, behavior, attitudes, and resilience. These technologies also provide innovative and effective training and mentoring methods to ensure Soldiers, leaders, and units have the knowledge, skills, and abilities to sustain positive unit climates and meet mission requirements in uncertain and complex environments. This Project evaluates new selection measures, refines performance metrics, assesses 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.

Efforts in this Project support the Army Science and Technology Soldier portfolio.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Human Capital Strategy.

Work in this Project is performed by the Army Research Institute (ARI) for the Behavioral and Social Sciences in Ft. Belvoir, VA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Personnel	7.916	14.050	9.000
Description: Conduct applied research that provides the Army with improved predictability of potential performance, behaviors, attitudes, and resilience of Soldiers, as well as an improved ability to recruit and sustain an effective career force.			
FY 2016 Accomplishments: Developed and validated new individual difference measures for predicting the job performance of Army strategic planners; developed a scientifically valid combination of pre-commissioning indices and non-cognitive measures for predicting officer job performance across multiple branches/functional areas; developed new assessments for predicting performance in cyber-related jobs.			
FY 2017 Plans:			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602785A / *Manpower/Personnel/ Training Technology*	**Project (Number/Name)** 790 / *Personnel Performance & Training Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will validate new assessments for predicting performance in cyber-related jobs; Will create leader self-development feedback packages to accelerate career progression; Will develop non-cognitive assessments for officer job performance and/or advancement within a branch. ***FY 2018 Plans:*** Conduct research on developing integrated assessments (i.e., comprehensive (vs. single) personnel assessments) for predicting high-potential Soldiers and high-risk behavior (i.e., integrated measures collected across the Soldier Lifecycle that feeds holistic assessments and predictive models of behaviors, performance, and outcomes).			
Title: Personnel Readiness and Performance ***Description:*** This effort investigates and develops effective training and leader development methods to assess, enhance, and sustain individual and unit readiness, resilience, and effectiveness. ***FY 2016 Accomplishments:*** Developed assessment methods and identified pre-cursor factors for unit resilience to enhance unit and Soldier readiness. Designed and developed exemplar measures, methods, and resources to support effective training and leader development for junior non-commissioned officers (NCOs). Designed and developed prototype measures and methods for small-unit leaders to improve Soldier readiness. Developed job aids for core cognitive and behavioral skills that enhance Soldier readiness. ***FY 2017 Plans:*** Will initiate research to develop measures of individual resilience and for assessing unit cohesion and unit resilience; will continue research to develop training methods to promote behavior and attitude change in units. ***FY 2018 Plans:*** Start research to create integrated assessments of individual Soldier and unit readiness (Holistic training methods: combining traditional, lecture-based training, with integrative learning methods which are training techniques that allow for connections among concepts/experiences so that information/skills can be applied to novel and complex issues or challenges).	11.482	5.795	7.506
Title: Army Leadership and Culture ***Description:*** This effort will investigate and develop efficient and empirically valid measures and methods to assess command climate and associated outcomes. Develop methods to enable leaders and units to ensure climates of dignity, respect, and inclusion. ***FY 2016 Accomplishments:***	3.076	6.200	3.710

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602785A / *Manpower/Personnel/ Training Technology*	**Project (Number/Name)** 790 / *Personnel Performance & Training Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Conducted research on empathy-based training methods to prevent and reduce the incidence of sexual harassment and assault; developed scientifically valid on-the-job resources to enable Army leaders to shape and influence unit climate. ***FY 2017 Plans:*** Will initiate research to identify behaviors (e.g., hazing, bullying, sexual harassment/assault, cyber aggression) that detract from unit morale, cohesion, and readiness; Will develop new training methods that target attitude and behavioral change to support improved morale, cohesion, and readiness in small units. ***FY 2018 Plans:*** Conduct research to develop methods and tools that enable Army leaders to build improved morale, cohesion, and readiness in small units; Start research to identify and measure command climate factors that predict overall unit readiness.			
Accomplishments/Planned Programs Subtotals	22.474	26.045	20.216

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602786A / *Warfighter Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	38.420	37.403	39.559	-	39.559	35.518	36.542	36.628	35.930	-	-
283: *Airdrop Adv Tech*	-	3.057	3.432	3.818	-	3.818	0.000	0.000	0.000	0.000	-	-
E01: *Warfighter Technology Initiatives (CA)*	-	3.500	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-
H98: *Clothing & Equipm Tech*	-	26.885	26.571	27.450	-	27.450	35.518	36.542	36.628	35.930	-	-
H99: *Joint Service Combat Feeding Technology*	-	3.290	4.919	5.051	-	5.051	0.000	0.000	0.000	0.000	-	-
VT4: *Expeditionary Mobile Base Camp Technology*	-	1.688	2.481	3.240	-	3.240	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

This Program Element (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), combat clothing and personal equipment including protective equipment such as personal armor, helmets, and eyewear (Project H98), combat rations and combat feeding equipment (Project H99), and expeditionary base camps (Project VT4). This PE supports the investigation and advancement of critical knowledge and understanding of Soldier physical and cognitive performance. Project E01 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.

Efforts in this PE support the Army Science and Technology Soldier/Squad Portfolio.

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).

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 led, performed, and/or managed by the Army Natick Soldier Research, Development, and Engineering Center (NSRDEC), Natick, MA.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army					Date: May 2017
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*			R-1 Program Element (Number/Name) PE 0602786A *I Warfighter Technology*		
B. Program Change Summary ($ in Millions)	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**
Previous President's Budget	39.295	37.403	34.475	-	34.475
Current President's Budget	38.420	37.403	39.559	-	39.559
Total Adjustments	-0.875	0.000	5.084	-	5.084
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.875	-			
• Adjustments to Budget Years	0.000	0.000	5.084	-	5.084

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2016	FY 2017
Project: E01: *Warfighter Technology Initiatives (CA)*		
Congressional Add: *Program Increase*	3.500	-
Congressional Add Subtotals for Project: E01	3.500	-
Congressional Add Totals for all Projects	3.500	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army									Date: May 2017			
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 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
283: *Airdrop Adv Tech*	-	3.057	3.432	3.818	-	3.818	0.000	0.000	0.000	0.000	-	-

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.

Efforts in this Project support the Army Science and Technology Soldier/Squad Portfolio.

The cited work is consistent with Assistant 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 Program Element (PE) 0603001A (Warfighter Advanced Technology).

Work in this Project is led, performed, and/or managed by the Army Natick Soldier Research, Development, and Engineering Center (NSRDEC), Natick, MA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Airdrop/Aerial Delivery Research and Technology	3.057	3.432	3.818
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/Project 242.			
FY 2016 Accomplishments: Investigated adaptive flight software to overcome rigging errors and broken control lines of Joint Precision Aerial Delivery System cargo parafoils; utilized M&S of parafoil type decelerators to determine optimum location of actuators for increased control authority and minimize actuator quantities to optimize future system cost; conducted assessment of technologies to increase airdrop system stealth capability while in flight and after impact; continued further advancements of life saving paratrooper static line reserve parachute automatic activation technologies.			
FY 2017 Plans:			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** 283 / *Airdrop Adv Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Study, design, and conduct experiments with precision aerial delivery software and hardware components to enhance high altitude precision aerial delivery capabilities in Global Positioning System (GPS)-denied areas, urban terrains, and jungle environments; investigate novel textiles for parachute applications that enable material properties to be customized which can enhance parachute performance; investigate non-destructive inspection methodologies for helicopter sling load cordage components; refine and validate software algorithms for static line reserve parachute automatic activation technologies. ***FY 2018 Plans:*** Will conduct M&S supporting aerial delivery system analyses to establish a baseline for personnel and cargo airdrop systems utilizing several high- and low-fidelity M&S tools; investigate and analyze results of full-scale wind tunnel experiments and methods for determining parachute shelf/service life; mature software algorithms that support the static line reserve parachute automatic activation sensor technologies in order to better detect parachute malfunctions and record and analyze jump data; investigate precision airdrop enhancements that will expand GPS-denied capabilities to include nighttime operations and design control systems to enhance low-cost airdrop system accuracy.			
Accomplishments/Planned Programs Subtotals	3.057	3.432	3.818

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army											Date: May 2017	
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 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
E01: *Warfighter Technology Initiatives (CA)*	-	3.500	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Warfighter Technology Applied Research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017
Congressional Add: Program Increase	3.500	-
FY 2016 Accomplishments: Program Increase		
Congressional Adds Subtotals	3.500	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
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 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
H98: *Clothing & Equipm Tech*	-	26.885	26.571	27.450	-	27.450	35.518	36.542	36.628	35.930	-	-

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, and electro-textiles for power generation and distribution. 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 Army Science and Technology Soldier/Squad Portfolio.

Work in this Project is coordinated with Program Element (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).

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 in this Project is performed by the Army Natick Soldier Research, Development, and Engineering Center (NSRDEC), Natick, MA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Soldier Blast, Ballistic, and Sensory Protection	5.042	6.858	13.452
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-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/Project FH2, PE 0602787A/Project VB3, PE 0602787A/Project 874, PE 0602618A/H80, PE0602105A/Project H84, PE0602716A/Project H70, PE 0603001A/Project J50, and PE 0603001A/Project FF6. This effort supports the Force Protection Soldier & Small Unit capability research and addresses the Army top challenge of easing overburdened Soldiers in small units.			
FY 2016 Accomplishments: Completed development of laboratory method of simulating and measuring forces and accelerations induced by blast overpressure on headborne equipment; investigated concepts for improving the above method through inclusion of a biofidelic			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** H98 / *Clothing & Equipm Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
neck that provides accurate, gender-specific simulation of the dynamic mechanical behavior of the human neck to improve the validity of the results; continued development of head and torso protection concepts for small arms and fragment protection using novel materials and assembling approaches to reduce weight while maintaining/improving penetration performance; completed development of standardized methodology to assess anthropometric design (fit, area of coverage, and comfort) impacts on body armor system performance. ***FY 2017 Plans:*** Continue the development of the biofidelic neck model which will provide a more accurate simulation of the dynamic behavior of the human neck when encountering blast impacts; develop and validate novel fibers, textiles, and components that enhance ballistic protection performance in equipment while reducing Soldier thermal and weight burden; develop enhanced materials, components, and models that mitigate Soldier injuries from blunt impact to head and extremities; continue the development of materials, processes, experiments, and validation tools that reduce threat of injury to the head from ballistic penetration or behind-the-helmet blunt trauma. ***FY 2018 Plans:*** Will conduct experiments to determine the efficacy of a combat helmet ballistic test methodology tied to modeling capabilities that correlate results with behind helmet blunt trauma injury; investigate new energy absorbing materials and subsystem components for helmet blunt impact protection systems; mature casualty reduction assessment tools and modeling capability; conduct experiments on next generation fiber technologies and material processing techniques with potential for enhancing fiber strength and advancing ballistic protection at reduced weight; validate pixelated lens technology applied on a ballistic fragmentation eyewear lens platform with ability to respond and protect against point and broadband light sources; determine the ability to detect and locate exposure to non-visible laser sources and other threats; investigate high transmission laser eye protection technology and evaluation procedures; conduct experiments on hard armor torso protection ceramic and composite backing materials to explore significant weight reduction opportunities; fund research to investigate alternative or new test methods and corresponding modeling and simulation for torso protection.			
Title: Soldier Vision Protection and Enhancement	2.820	3.100	-
Description: This effort focuses on the investigation of technologies that provide eye protection against battlefield threats. This effort supports the Force Protection Soldier and Small Unit capability research and addresses the Army top challenge of easing overburdened Soldiers in small units. This effort is fully coordinated with PE 0602787A/Project FH2, PE 0602787A/Project VB3, PE 0602787A/Project 874, PE 0602618A/H80, PE0602105A/Project H84, PE0602716A/Project H70, PE 0603001A/Project J50, and PE 0603001A/Project FF6. In Fiscal Year (FY) 18, this effort will be incorporated into this PE's Soldier Blast, Ballistic, and Sensory Protection Program.			
FY 2016 Accomplishments:			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** H98 / *Clothing & Equipm Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Designed breadboard proof of concept for pixilated lens technology that maintains peripheral vision while mitigating laser threats; investigated feasibility of alternative material solutions for tunable laser protection that enable selective blocking of laser threats while maintaining non-threatening light transmission; investigated feasibility of enhancing Soldier vision performance (e.g., on-demand telescopic vision capability) using waveplate technology. ***FY 2017 Plans:*** Investigate the application of the pixelated lens technology on a ballistic fragmentation eyewear lens platform; design proof of concept for enhanced Soldier vision and auditory system technology; conduct experiments to refine the ability to respond and protect against point and broadband light sources using a pixilated lens approach; investigate the ability to detect and locate exposure to non-visible laser sources and other threats; investigate how specific novel visual protective technologies impact visual acuity and Soldier perceptual capabilities and determine the impact on a wide range of Soldier tasks such as movement from indoor to outdoor environments, marksmanship, and move-shoot.			
Title: Measurement, Prediction, and Improvement of Soldier Performance ***Description:*** This effort provides a comprehensive investigation of human science methods (psychological, anthropometric, and psychophysical) and biomechanical models to assess human responses to sensory, physical, cognitive, and affective stimuli and stressors. This investigation supports the development of human systems design concepts for Soldier equipment and enhances Soldier and small unit physical and cognitive performance. This work is collaborative with the Army Research Laboratory PE 0602716A/H70 and the Medical Research and Materiel Command PE 0602787A/Project FH2, PE 0602787A/Project VB3, and PE 0602787A/Project 874. This effort supports the Force Protection Soldier & Small Unit capability research and addresses the Army top challenge of easing overburdened Soldiers in small units. ***FY 2016 Accomplishments:*** Continued the Soldier System Engineering Architecture (SSEA) development by verifying and initiating validation of the suite of human systems performance measurements, approaches, and field analytical tools that comprise the human systems building blocks of this framework; investigated the psychological, anthropometric, and biomechanical impacts on modifications to Soldier system components and sub-systems on survivability and combat effectiveness; investigated the concept of leveraging and linking existing Soldier capabilities with emerging modeling and analytical techniques to increase scientific rigor of Soldier system experiments that reduce risk and cost of system development while increasing Soldier and small unit performance; designed standard assessment methodologies, based on operational tasks, that define the relationship between Soldier performance and his/her equipment and configurations; designed population-level analysis design tool for creating human model of Soldier's size and shape based on statistical methods; defined a repeatable standard method for obtaining accurate three-dimensional (3D) models of equipped Warfighters to develop the ability to model any Warfighter size/shape, in any pose, with 3D gear and casualty estimation. ***FY 2017 Plans:***	8.510	9.459	7.863

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** H98 / *Clothing & Equipm Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Study the effects of incorporating physical, cognitive, and social performance metrics into the SSEA human performance tools to identify their impacts on equipment and mission tasks; investigate emerging human science measures and metrics such as load mitigation, encumbered movement impact to mission performance, and assessment of physical and cognitive augmentation to increase understanding of human performance in a military environment; conduct experiments to increase understanding of factors that optimize human performance in biomechanics, anthropometry, and cognition measures; validate predictive data with Soldier performance tools and simulations. ***FY 2018 Plans:*** Will investigate the utility of non-invasive physical human performance metrics data collection with respect to specific Warfighter tasks; continue to conduct experiments that monitor, predict, and optimize cognitive, physical, and social measures of the Soldier; validate common criteria for measures of Soldier performance while conducting military relevant tasks; investigate the validity, reliability, and sensitivity of obstacles utilized within the Load Effects Assessment Program (LEAP); validate interactions and physical interfaces between the Soldier, equipment, and physical tasks; mature benchtop representation of the Warfighter's gut microbiome model to investigate and characterize the effects of dietary inputs on the performance of a Soldier's internal anatomy; fund research and conduct experiments to understand the physiological mechanisms necessary to advance a Soldier's natural physical and cognitive abilities.			
Title: Advancements in Fibers, Textiles, and Materials for Soldier Protection	10.513	7.154	6.135
Description: This effort focuses on the investigation of technologies and test methods that aid in the design and development of multifunctional protective materials for Soldier clothing and individual equipment. This effort includes the development and maturation of flame, thermal, environmental, and multispectral concealment capabilities, as well as novel desalinization and purification technologies for individual Soldier hydration, combat identification technologies, and electro-textiles for power generation and distribution. This effort supports the Force Protection Soldier and Small Unit capability research. This effort is fully coordinated with PE0602105A/Project H84, PE0602716A/Project H70, and PE 0603001A/Project J50. ***FY 2016 Accomplishments:*** Matured thermal signature reduction technologies and associated modeling tools for prediction of material performance in a range of simulated environments; continued to investigate incorporation of improved, low toxicity, narrow spectrum antimicrobial and insect repellent treatments into textiles appropriate for Soldier clothing and individual equipment; matured improved flame resistant and no melt/no drip fibers, coatings, and textiles for incorporation into combat clothing and individual equipment; continued development of improved combat identification technologies and electrotextiles for power generation/distribution and personal thermal management. ***FY 2017 Plans:*** Develop second generation materials and combat uniform components that significantly reduce Soldier thermal signature; investigate novel textile technologies to provide protection against microbes, insect-borne diseases, climate extremes, flame/			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** H98 / *Clothing & Equipm Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
thermal threat, and microwave directed energy threats; continue maturation of improved Soldier combat identification technologies and electrotexiles for power generation/distribution and personal thermal management; investigate use of improved models and simulated skin samples for improved burn injury prediction of human skin; identify, design, and develop lightweight personal hydration and thermal management concepts to enhance dismounted Soldier performance in jungle/tropical environments. ***FY 2018 Plans:*** Will investigate and develop desalination capabilities for individual Soldier hydration systems; design and develop novel textile architectures and weaves to provide protection against microwave frequency hazards through reflection and scattering of directed energy threats; investigate quantum dots and novel film applications as possible mechanisms to improve combat identification; investigate and develop microrectenna arrays for Soldier worn combat identification and energy conversion; investigate thermally adaptive fibers and technologies which provide improved thermal protection in cold and extreme cold weather environments; investigate carbon based conductive fibers and flexible materials for incorporation into textiles for optimized Soldier worn energy distribution.			
Accomplishments/Planned Programs Subtotals	26.885	26.571	27.450

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602786A / *Warfighter Technology*	Project (Number/Name) H99 / *Joint Service Combat Feeding Technology*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
H99: *Joint Service Combat Feeding Technology*	-	3.290	4.919	5.051	-	5.051	0.000	0.000	0.000	0.000	-	-

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 Program Element (PE) 0603001A/Project C07 for maturation.

Efforts in this Project support the Army Science and Technology Soldier/Squad Portfolio.

Work in this Project is fully coordinated with PE 0602787A (Medical Technology) and PE 0603001A (Warfighter Advanced Technology).

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 in this Project is led, performed, and/or managed by the Army Natick Soldier Research, Development, and Engineering Center (NSRDEC), Natick, MA, and this Project has collaborative efforts with the Army Research Institute for Environmental Medicine.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Joint Combat Feeding Technologies	3.290	4.919	5.051
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/Project 869 and PE 0603001A/ Project C07.			
FY 2016 Accomplishments:			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** H99 / *Joint Service Combat Feeding Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Investigated alternate refrigerant systems in support of containerized deployable refrigeration assets to address environmental concerns with current generation refrigerants; investigated nutritional countermeasures through identification and stabilization of functional nutrients, such as dietary ketone esters, into shelf stable operational rations to improve recovery time from exertion or injury as well as provide potential systemic health benefits; investigated novel food processing technologies in support of improved nutrient retention, reduced manufacturing costs, and increased consumer acceptability; investigated and developed optimized sampling procedures in support of next generation diagnostic systems for food protection to increase the sensitivity and selectivity of field portable sensors for pathogenic bacteria and toxins. ***FY 2017 Plans:*** Explore ration nutritional strategies for components targeted at optimizing the gut microbiome to reduce gastrointestinal distress; investigate refrigeration technologies for reduced energy consumption and modularity; investigate ration compounds to promote recovery and optimize performance; research the detection, prevention, and reduction of pathogenic bacteria and toxins in foods; investigate novel self-repairing/heating packaging materials to enhance food protection and quality; explore technologies for three-dimensional printing of ration components. ***FY 2018 Plans:*** Will develop ration formulations containing proven nutritional strategies to optimize the gut microbiome and improve warfighter cognitive performance under stressful conditions; investigate heat transfer methods to enable high efficiency operation of field feeding appliances while reducing power requirements; identify nutritional interventions that promote recovery from strenuous exercise or mitigate oxidative stress; investigate portable biosensor detection platforms to improve food safety; design alternative packaging configurations that decrease ration weight; validate improved nutrient content of foods processed using non-thermal or low-thermal methods to improve warfighter nutritional status; develop model food formulations that retain desired sensory characteristics after creation via three-dimensional (3D) printing.			
Accomplishments/Planned Programs Subtotals	3.290	4.919	5.051

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602786A / *Warfighter Technology*	Project (Number/Name) VT4 / *Expeditionary Mobile Base Camp Technology*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
VT4: *Expeditionary Mobile Base Camp Technology*	-	1.688	2.481	3.240	-	3.240	0.000	0.000	0.000	0.000	-	-

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 Army Science and Technology Soldier/Squad Portfolio.

Work in this Project is fully coordinated with Program Element (PE) 0602784A and 0603734A (Military Engineering 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).

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 in this Project is led, performed, and/or managed by the Army Natick Soldier Research, Development, and Engineering Center (NSRDEC), Natick, MA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Expeditionary Base Camp Component Technologies	1.688	2.481	3.240
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/Project VT5, PE 0602786A/Project H99 and is coordinated with PE 0602784A/Project T40, PE 0603734A/Project T08, PE 0603004A/Project L97, PE 0603005A/Project 497, PE 0603125A/Project DF5, and PE 0603772A/ Project 101.			
FY 2016 Accomplishments: Investigated increased flame resistance for shelter materials and fire safety for shelters to ensure Soldiers are provided with safe living environments; matured novel materials for power generating shelter materials to decrease logistical burden and fuel demands; researched rapid expeditionary basing deployment techniques to increase efficiency and support a leaner force;			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** VT4 / *Expeditionary Mobile Base Camp Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
investigated technologies that support self-sufficiency of basing logistics; matured components of black waste systems to ensure a hygienic environment; designed lightweight novel multifunctional panel materials for rigid wall shelters; investigated multifunctional materials for basing applications that can produce increased protections for overmatch capabilities and reduce exposure to insects. ***FY 2017 Plans:*** Investigate tradeoffs between base camp efficiency, scalability, and Soldier quality of life for optimal readiness and minimal degradation to missions; conduct experiments on microscale alternative field service energy technologies to enable self-sufficient base camps that decrease the logistical burden and cost; investigate novel thermal insulation material and coating technologies for rigid wall tactical shelters to enhance shelter energy efficiency; investigate and design novel solutions to characterize and mitigate emerging ballistic threats to integrated shelter basing systems including potential reactive technologies to increase overmatch. ***FY 2018 Plans:*** Will identify operational effectiveness measures and explore correlation between expeditionary maneuver, base camp sustainment, and operational quality of life optimized for Soldier readiness in order to incorporate mission effectiveness into the development of self-sufficient base camp technology; investigate alternative energy technologies to improve efficiency, durability, and adaptability to a base camp environment; mature thermal insulation material to enhance energy efficiency for expeditionary shelter; investigate technical approaches for expeditionary structures to mitigate visual, thermal, and electromagnetic infrared signatures; validate ballistic protective shelter material and design technologies with simulated emerging threats; investigate concepts of additive manufacturing technologies for in-theatre shelter component fabrication to reduce overall logistics tail.			
Accomplishments/Planned Programs Subtotals	1.688	2.481	3.240

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602787A / *Medical Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
Total Program Element	-	74.186	77.111	83.434	-	83.434	79.555	81.087	79.367	80.935	-	-
869: *Warfighter Health Prot & Perf Stnds*	-	28.717	37.409	40.201	-	40.201	33.417	35.033	37.739	38.808	-	-
870: *Dod Med Def Ag Inf Dis*	-	18.756	20.478	22.234	-	22.234	21.923	22.361	19.711	20.115	-	-
874: *Cbt Casualty Care Tech*	-	16.476	10.033	11.127	-	11.127	9.805	10.434	10.432	10.568	-	-
ET4: *Appl Resch in Clinical and Rehabilitative Medicine*	-	0.000	7.273	7.871	-	7.871	12.335	11.143	9.314	9.229	-	-
FH2: *Force Health Protection - Applied Research*	-	5.094	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-
VB4: *System Biology And Network Science Technology*	-	5.143	1.918	2.001	-	2.001	2.075	2.116	2.171	2.215	-	-

Note

In Fiscal Year (FY) 2015 and 2016 Project 874 funds both Combat Casualty Care and Clinical and Rehabilitative Medicine efforts. In FY17 the Clinical and Rehabilitative Medicine efforts will be funded in Project ET4. Starting in FY17 the FH2 funding and research will be merged into Project 869. Additionally, starting in FY17 the toxic substances research efforts will move from Project VB4 to Project 869.

A. Mission Description and Budget Item Justification

This Program Element (PE) supports application of knowledge gained through basic research to refine drugs, vaccines, medical devices, diagnostics, medical practices/ procedures, and other preventive measures essential to the protection and sustainment of Warfighter health. Research is conducted in five principal areas: Combat Casualty Care; Military Operational Medicine; Military Relevant Infectious Diseases Clinical and Rehabilitative Medicine; and Systems Biology/Network Sciences.

Research is funded in six projects.

Project 869 refines knowledge and technologies on screening tools and preventive measures for Post-Traumatic Stress Disorder (PTSD) and mild traumatic brain injuries, physiological monitors, and interventions to protect Warfighter's 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 Program. Starting in FY17 the FH2 funding and research will be consolidated into this project. Additionally, starting in FY17 the toxic substances research efforts will move from project VB4 to project 869.

Exhibit R-2, RDT&E Budget Item Justification: FY 2018 Army	Date: May 2017
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602787A *I Medical Technology*

Project 870 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 Program.

Project 874 identifies and evaluates drugs, biologics (medical products derived from living organisms), medical devices, and diagnostics for field trauma care systems, resuscitation, and life support, and post-evacuation restorative and rehabilitative care. Focus is identifying more effective critical care technologies and clinical practice guidelines to treat severe bleeding, traumatic brain injury, burns and other combat related traumatic injuries, and treatments for ocular (eye) injury and visual system dysfunction. Additional focus areas are laboratory and animal studies of regenerating skin, muscle, nerves, vascular and bone tissue for the care and treatment of wounded Service Members. This Project is being coordinated with the Defense Health Program. In FY15 and 16 this Project funds both Combat Casualty Care and Clinical and Rehabilitative Medicine efforts. Starting in FY17 the funding for Clinical and Rehabilitative Medicine Research Program moves from Project 874 to Project ET4.

Project ET4, which is a restructure of efforts funded elsewhere in this Program Element, starts in FY17 and the funding for the Clinical and Rehabilitative Medicine Research Program moves from Project 874 to Project ET4. Project ET4 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 being coordinated with the Defense Health Program.

Project FH2 conducts applied research focused on sustainment of a healthy Warfighters throughout the entire deployment life cycle. Starting in FY17, Project FH2 funding and research will be consolidated into Project 869.

Project VB4 includes applied research in systems biology to provide a highly effective mechanism to integrate biological tests and computer simulations in clinical trials and in animal studies. The PTSD and Coagulopathy exemplars have demonstrated the power of an iterative systems biology approach and are moving projects related to objective diagnostics and improved and personalized therapeutic strategies. Development of the SysBioCube (a data analysis, management and integration system) has provided the ability for complex collaborative efforts to share, process and evaluate data using innovative technologies. These concerted refinement efforts using systems biology are showing reduction of time and funding for solutions to intractable problems of critical military importance. Starting in FY17 the toxic substances efforts will move from Project VB4 to Project 869.

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

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 6.3 Advanced Technology Development). This PE focuses on research and refinement of technologies such as product formulation and purification and

laboratory test refinement with the aim of identifying candidate solutions. This work often involves testing in animal models. The EPA also requires thorough testing of products, such as sterilants, disinfectants, repellents, and insecticides to ensure the environment is adequately protected before these products are licensed for use.

Program refinement and execution is externally peer-reviewed and fully coordinated with all Services as well as other agencies through the Joint Technology Coordinating Groups of the Armed Services Biomedical Research Evaluation and Management (ASBREM) Community of Interest (COI). The ASBREM COI, formed under the authority of the Assistant Secretary of Defense for Research and Engineering, serves to facilitate coordination and prevent unnecessary duplication of effort within the Department of Defenses (DoD) biomedical research and refinement community, as well as their associated enabling research areas.
Work funded in this PE is fully coordinated with efforts undertaken in PE 0603002A (Medical Advanced Technology) and the Defense Health Program.

Work in this PE is performed by the Walter Reed Army Institute of Research (WRAIR), Silver Spring, MD and its overseas laboratories; Army Medical Research Institute of Infectious Diseases (USAMRIID) and the Armed Forces Institute of Regenerative Medicine (AFIRM), Fort Detrick, MD; Army Center for Environmental Health Research (USACEHR), Fort Detrick, MD; Army Research Institute of Environmental Medicine (USARIEM), Natick, MA; the Army Institute of Surgical Research (USAISR), Joint Base San Antonio, TX; Army Aeromedical Research Laboratory (USAARL), Fort Rucker, AL; and the Naval Medical Research Center (NMRC), Silver Spring, MD.

B. Program Change Summary ($ in Millions)	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total
Previous President's Budget	76.853	77.111	82.334	-	82.334
Current President's Budget	74.186	77.111	83.434	-	83.434
Total Adjustments	-2.667	0.000	1.100	-	1.100
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.872	-			
• SBIR/STTR Transfer	-1.795	-			
• Adjustments to Budget Years	0.000	0.000	0.877	-	0.877
• Civ Pay Adjustments	0.000	0.000	0.223	-	0.223

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army										Date: May 2017		
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 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
869: *Warfighter Health Prot & Perf Stnds*	-	28.717	37.409	40.201	-	40.201	33.417	35.033	37.739	38.808	-	-

Note

Starting in Fiscal Year (FY) 2017 Project FH2 (Force Health Protection – Applied Research) funding and research efforts are merged into Project 869. Additionally in FY17 the toxic substances research and funding will move from Project VB4 (System Biology And Network Science Technology) into Project 869.

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 provide greater insight into informing new research in development of Warfighter systems and the interactions between Warfighters and the systems they employ.

Promising efforts identified in this Project are further matured under Program Element (PE) 0603002A (Medical Advanced Technology) / Project MM3 (Warfighter Medical Protection & Performance).

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

Work in this project is performed by the Walter Reed Army Institute of Research (WRAIR), Silver Spring, MD; the United States Army Research Institute of Environmental Medicine (USARIEM), Natick, MA; the United States Institute of Surgical Research (USAISR), Joint Base San Antonio, TX; and the United States Army Aeromedical Research Laboratory (USAARL), Fort Rucker, AL.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 869 / *Warfighter Health Prot & Perf Stnds*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Physiological Health - Nutritional Sustainment and Fatigue Interventions	2.617	3.105	4.679
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. ***FY 2016 Accomplishments:*** Determined the role of eating rate in energy balance. Established the effects of nutritional interventions on the localized immune response during wound healing. Determined the effectiveness of novel feeding platforms (dining facility organization) for the improvement of dietary quality during garrison feeding. Determined relevant predictors, moderators and outcome metrics that enhance the ability to predict a Warfighters capacity to recover quickly, both mentally and physically. Established a capability to sense and predict physiological responses in individual Warfighters following exposure to environmental stressors or during operational missions. ***FY 2017 Plans:*** Will perform field experiments to establish nutritional parameters that can enhance resistance to stress and augment wound healing. Will evaluate how nutritional interventions can enhance recovery of brain function following caloric deficit. Will determine the effectiveness of a prophylactic (treatment for prevention of disease) nutrient or dietary nutrient cocktail for improving deleterious effects of impact, acceleration, and/or blast –induced head injury. Will validate a preliminary descriptive model outlining factors linking the central nervous system and other organs/ systems that impact resilience, using data from field studies. Will down select candidate physiological biomarkers (indicator of a process, event, condition or change within the body) of resilience based upon objective measures of success during relevant Military scenarios. Will conduct laboratory study to evaluate intra-individual (trait) responsivity under varied sleep loss conditions. ***FY 2018 Plans:*** Will conduct one or more field studies to determine the efficacy of energy and/or protein supplementation for preventing declines in lean body mass and cognition during and after caloric deficit (shortage of calories consumed). From the results of field studies, will continue to develop a descriptive model outlining factors linking the central nervous system and other organs/systems that impact resilience. Will assess the effect of nutritionally optimized snack products for maintaining body composition and nutritional status during and after military training and operations in a field study. Will develop interventions promoting resistance to physical, cognitive and environmental stressors. Will evaluate the role of nutritional factors in the maintenance of physiological and neurobehavioral health under operationally relevant conditions. Will analyze the effects of nutritional interventions on indicators of nutritional status. Will demonstrate the effectiveness of nutrient and dietary strategies (e.g., omega-3 polyunsaturated fatty acids, zinc, and hydration) for reducing the vulnerability to and/or accelerating the recovery from mild traumatic brain injury (mTBI).			
Title: Concussion/Mild Traumatic Brain Injury (mTBI) Interventions	-	2.422	2.296
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			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 869 / *Warfighter Health Prot & Perf Stnds*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
and the senses) and risk factors for spinal injury in Military vehicle occupants during operations. In FY17 this effort moves from Project FH2 to Project 869. ***FY 2017 Plans:*** Will determine incidence and risk factors for spinal injury and evaluate the military vehicle occupant environment. Will develop provisional spinal injury criteria and assessment methods for occupant protection. Will determine the severity and duration of neurobehavioral and neuropathological (behavioral traits and structure of the brain) disruptions resulting from re-exposure to blast and/or impact-induced head injuries with intervals between insults ranging from 1 to 72 hours and compared to single head insults. Will determine if a traumatic underwater stressor or intermittent electric shock can infer heightened vulnerability to mTBI by comparison of the magnitude and duration of functional impairments resulting from blast mTBI alone using a small animal model. ***FY 2018 Plans:*** Will develop models of military vehicle occupant exposures that will be used for predicting cervical spine injury risk. Will collect exposure outcome data from the operational environments to improve provisional spinal injury criteria and assessment methods for occupant protection. Will assess the effects of sleep duration, timing, and continuity of mTBI patients versus controls using actimetry sensors (non-invasive method of monitoring human activity/rest cycles) with the goal of determining differences in baseline sleep between mTBI patients, non-mTBI controls, and recovered mTBI controls in their home environments.			
Title: Environmental Health and Protection - Physiological (human physical and biochemical functions) Awareness Tools and Warrior Sustainment in Extreme Environments ***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. ***FY 2016 Accomplishments:*** Performed laboratory and field studies to refine predictive models of altitude sickness, acclimatization status, and work performance at high altitude. Developed a mobile application for a personal computer-based Altitude Readiness Management System decision aid, and automated altitude acclimatization monitor for a rapid ascent to high altitudes. Determined if thermoregulatory (ability of an organism to keep its body temperature within certain boundaries) fatigue or high altitude exposures increase susceptibility of non-freezing cold injury and hypothermia. Determined if localized warming improved peripheral blood circulation and also decrease susceptibility to non-freezing cold injury. Established the effectiveness of novel pharmaceutical treatments for heat injury in an animal model to inform the development of promising drug interventions proposed to reduce the severity or alleviate organ damage and enhance recovery.. ***FY 2017 Plans:***	1.446	1.578	1.380

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 869 / *Warfighter Health Prot & Perf Stnds*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will determine the combined impact of heat, humidity, and altitude on human health and performance and will research mitigation strategies to enhance tolerance and sustain performance against environmental injury or environmental threats. Will determine the reliability, reproducibility, and validity of a militarily-relevant dexterity assessment instrument during cold-air exposures. Will determine the scientific basis for developing focused heating and cooling solutions for improved peripheral blood circulation to maintain fine motor hand dexterity, core and skin temperatures, and optimize physical and cognitive performance during extreme climate operations. ***FY 2018 Plans:*** Will evaluate the reliability, reproducibility, and validity of a novel militarily-relevant dexterity assessment instrument during cold-air exposures. Will develop a low-power microclimate forearm heating prototype to maintain finger blood flow and hand dexterity during cold-air exposures. Will determine the areas on the human that, when warmed, cause a physiological reflex response that increases finger blood flow and maintains manual dexterity in a cold environment.			
Title: Biomarkers of Exposure and Environmental Biomonitoring (measurement of the body's response to toxic chemical compounds, elements, or their metabolites, in biological substances) ***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. The funding for this research effort was previously in Project VB4 and moved to Project 869 in FY17. ***FY 2017 Plans:*** Will utilize an integrated experimental and computational platform to evaluate host responses to environmental hazards in terms of pathogenic and adaptive processes. Will evaluate target mechanisms for drug efficacy and molecular diagnostics. Will determine candidate biomarkers of liver and kidney injury caused by military relevant chemicals and other environmental stressors. Will evaluate mathematical models that predict dose and time based host response biomarkers, in serum or urine, to metal and volatile organic compound toxicity. ***FY 2018 Plans:*** Will utilize an integrated experimental and computational platform to evaluate host responses to exposure (through the mouth, nose and skin) to environmental hazards (including toxic industrial chemicals [TICs] and metals such as chromium) in terms of pathogenic and adaptive processes. Will develop several physiological-based dosimetery models of toxicity for TICs and heavy metals with adverse outcome pathways of liver, kidney, cardiac, and/or neural injury based on published and experimentally-derived data. Model output will guide small unit decision making through the generation of actionable health risk information that	-	3.925	4.884

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 869 / *Warfighter Health Prot & Perf Stnds*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
can predict the risk of adverse health effects in Warfighters with high sensitivity and specificity. Will develop a methodology of evaluating central nervous system toxicity in order to determine sensitive and specific indicators of central nervous system injury.			
Title: Injury Prevention and Reduction - Neurosensory Injury Prevention ***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. ***FY 2016 Accomplishments:*** Performed crash and blast relevant vertical acceleration experiments to determine improved predictions and diagnostics of spinal injury. Characterized middle ear function under impulse (sudden loud) noise for improvement of current hearing injury models. Validated test criteria, and developed predictive ocular (eye) injury algorithm to evaluate protective eyewear. ***FY 2017 Plans:*** Will continue collecting data from human volunteers on the middle ear's response to impulsive sounds; will begin evaluating the complex interaction between auditory and vestibular protective systems. Will determine threshold blast overpressure and impulse exposure leading to cellular level ocular injury and refine scaling laws to be able to relate experiments conducted in small animal models to exposure conditions in humans. ***FY 2018 Plans:*** Will assess the complex interaction between auditory and vestibular protective systems. Will validate blast exposure conditions that lead to cellular level ocular injury and continue to refine scaling laws to be able to relate experiments conducted in small animal models to exposure conditions in humans, which will enable the development of computational models that can help predict the effects of the primary blast wave on the eyes and visual system in humans. Will analyze potential neuroprotective (preserve nerve function) chemicals against primary blast injuries to the visual system. Will evaluate provisional mandible blunt impact injury risk using two models (Facial and Ocular Countermeasures for Safety Headform (FOCUS) and Post Mortem Human Subjects (PMHS) to improve standards requirements for Warfighter protective gear.	3.463	4.191	4.752
Title: Injury Prevention and Reduction - Musculoskeletal Injury Prevention ***Description:*** This effort evaluates and assesses the effects of repetitive motion during military operations and training on the human body; will provide 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. ***FY 2016 Accomplishments:***	3.054	4.481	3.249

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Utilize mathematical models of neuromuscular processes (central nervous system control of muscle functioning) to develop interventions that promote repair and regeneration following muscle injury and modify the inflammatory response and reduce the risk of incomplete healing or subsequent re-injury. Utilize knowledge of risk factors obtained from basic studies to develop interventions to prevent and mitigate risks in the training and operational environments that could lead to musculoskeletal (muscle, bone, tendons, and ligaments) injuries. ***FY 2017 Plans:*** Will determine the roles of endocrine (hormones) and intracellular signaling molecules (within the cell) involved in skeletal muscle and bone development, regeneration, and repair utilizing cell based animal and human models for transition to clinical trials. Will develop a mathematical model of ideal bone density and structure that offsets risk of stress fracture. Will evaluate situations that create unnecessary musculoskeletal risk hazards, and make recommendations for improvement. ***FY 2018 Plans:*** Will consolidate results from animal- and human-based studies to refine the roles of endocrine (i.e., hormonal) and intracellular (i.e., within the cell) signaling molecules that are involved in skeletal muscle and bone development, utilizing animal and human models for transition to clinical trials. Will refine a mathematical model of ideal bone density and structure that offsets risk of stress fracture. Will utilize the Total Army injury and Health Outcomes Database (TAIHOD) to evaluate situations that create unnecessary musculoskeletal risk-hazards, and provide recommendations for mitigation. Will analyze incidence and risk factors during the last 10 years for spinal injury in military personnel. Will study the military vehicle occupant environment for the development of vibration health hazard assessment models.			
Title: Injury Prevention and Reduction - Injury Return-to-Duty (RTD) Standards ***Description:*** This effort evaluates current standards for rapid RTD and establishes improved and validated medical standards and test methods with the goal of more rapid and safe RTD of injured Warfighters. Starting in FY17 the work performed here will be captured in other areas (Injury Prevention and Reduction - Neurosensory Injury Prevention and Injury Prevention and Reduction - Musculoskeletal Injury Prevention. ***FY 2016 Accomplishments:*** Developed standards based on current Warfighter trends of Warfighter injuries contributing to lost duty days, reduced mission effectiveness and occupational disability, specific to Military Occupational Specialties. Performed studies to update the neurosensory (sensory activity or functions of the nervous system) performance return to duty toolkit previously transitioned to the Defense Center of Excellence for Psychological health and TBI. Determined the effects of physical injury on military occupational performance and defined minimal standards for Warfighter performance prior to returning to duty.	2.636	-	-
Title: Psychological Health - Psychological Resilience	11.634	8.674	8.462

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018

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.

FY 2016 Accomplishments:
Explored the effectiveness of improved sleep quality and quantity on the recovery from concussion. Performed studies to improve a Mindfulness training package to develop recommendations for Comprehensive Warfighter and Family Fitness (CSF2). Analyzed data from previous studies to determine if an alcohol use screening questionnaire can be effectively used in Warfighters. Performed studies to revise Family resilience training across the deployment cycle. Developed evidence-based recommendations for identifying and addressing difficulties with post-combat adjustment. Conducted studies to verify whether a computer-based tool can help Warfighters deal with occupational stress and have more positive post-deployment outcomes, to include a reduction in anger symptoms. Performed studies to improve and validate unit-based resilience training for Reserve Components. Evaluated evidence-based behavioral health leader training. Provided recommendations for provider toolkit using sleep quality parameters to inform RTD decisions. Conducted studies to understand how to best increase Warfighter use of DoD provided behavioral health care. Extended the Systems Biology Enterprise PTSD biomarker research to identify biomarker differences, based on gender; biomarkers will aid in distinguishing PTSD from frequently co-occurring or co-morbidities i.e. Mild Traumatic Brain Injury and Major Depressive Disorder. Through pre- and post-deployment specimen collection, identified alterations in gastrointestinal and immune response systems signaling PTSD onset. Continued studies to determine if a diet formulated with a blend of omega-3 fatty acids, glutamine, Vitamin D3 and zinc provides enhanced resiliency against psychological stressors and acute head trauma, in a small animal model.

FY 2017 Plans:
Will initiate studies to determine if a diet formulated with a balanced omega-3/6 fatty acids ratio, glutamine, and antioxidants provides enhanced resiliency against psychological stressors (collaborative effort across task areas). Will compare animal models of PTSD to identify model strengths and weaknesses (biologic changes underlying behavioral response correlation) facilitating optimal matching/utilization of models to specific research objectives. Will evaluate PTSD diagnostic biomarkers specific to females, will evaluate PTSD disease trajectory (stages/subtypes) to inform early intervention and treatment selection. Will continue work to evaluate risk and resilience markers for Warfighters including those deploying to non-combat operations. Will document linkages between sleep problems and mission-related mistakes as well as suicide-related thoughts. Will continue to determine the risk and resilience markers for family functioning, specifically, the impact of military community transformation (downsizing and increasing) and deployment on family member health and marital functioning. Will continue to provide resilience training best practices by validating a measure of resilience training utilization and sleep awareness training. Will continue work to deliver a revised Unit Behavioral Health Needs Assessment tool. Will continue to conduct studies to verify whether a computer-based tool can help Warfighters deal with occupational stress and have more positive post-deployment outcomes, to include a

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
reduction in anger symptoms and optimize cognitive flexibility. Will deliver recommendations for implementation of unit-based social fitness training. Will develop measures of leadership behaviors for improving behavioral health, anger and risk-taking in units. Will deliver recommendations for increasing positive attitudes toward behavioral health care. Will provide recommendations for a provider toolkit to assist in return-to-duty decisions. Will continue studies to increase treatment engagement and adherence and determine best model for increasing provider use of evidence-based practices. ***FY 2018 Plans:*** Will determine if a diet formulated with a balanced omega-3/6 fatty acids ratio, glutamine, and antioxidants provides enhanced resiliency against psychological stressors in humans. Will evaluate the effects of novel compounds active in the glucocorticoid system (steroid hormones that are essential for the utilization of carbohydrate, fat and protein by the body and for the normal response to stress) and the endocannabinoid system (brain receptors that are involved in various physiological processes including appetite, pain sensation, mood and memory) for their ability to mitigate the adverse behavioral effects of traumatic stress and traumatic conditioning processes. Will evaluate at least one drug candidate modulating the activity of orexin/hypocretin (a peptide found in the nervous system that regulates arousal, wakefulness and appetite) for its ability to mitigate the adverse behavioral effects of traumatic stress and traumatic conditioning processes. Will continue studies focused upon identification of PTSD subtypes, stage of disease progression, and development of associated biomarkers for use in the identification and development of matched risk-based prevention interventions and development of a precision medicine algorithm approach to PTSD treatment. Will determine the influence of sleep history on the efficacy and durability of Attention Bias Modification Training (ABMT), which is a computerized treatment that involves retraining an individual's interpretation of other's facial expressions away from predisposed perceptions of hostility, shifting interpretations in the direction of neutrality, to reduce his or her level of anxiety. Will also conduct a study with Soldiers in an operational unit to determine the predictive validity of trial-by-trial attention bias analytics versus traditional measures. Will develop and pilot an evidence-based, self-discipline education program that positively influences Soldier outcomes related to resilience and readiness through the development of adaptive self-control and emotion regulation. Will develop and pilot emotion regulation leadership training modules for unit leaders. Will develop and pilot an evidence-based, team-level intervention that positively influences Soldier outcomes related to behavioral health, resilience, and unit readiness through the regulation of small-team dynamics (e.g., group-affect). Will develop and pilot an individual-to-tool matching paradigm that allows leaders to optimally tailor intervention strategies to precisely meet their personnel and operational health needs.			
Title: Psychological Health & Resilience - Suicide Prevention ***Description:*** This effort supports methods to identify and modify causative and preventive factors in military suicides. ***FY 2016 Accomplishments:***	0.865	0.954	4.873

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Continued to advance the study from FY15 efforts to determine whether a brief cognitive behavioral intervention can encourage Warfighters to seek treatment. Continued to develop evidence-based guidelines for leaders to manage suicide events. ***FY 2017 Plans:*** Will complete a study examining predictive ability of screening tools. Will continue the effort to deliver guidelines for leaders and complete analyses of study data to begin drafting guidelines on how to best handle suicide events. Will finish data collection and analysis to deliver a short cognitive behavioral intervention to encourage treatment seeking. Will begin work to target key high risk emotional and behavioral transition points to decrease suicide behaviors. ***FY 2018 Plans:*** Will assess key high risk emotional and behavioral transition points to decrease suicide behaviors. Will develop and refine guidelines and tools for leaders, which will include evidence-based recommendations for identifying and addressing difficulties with post-combat adjustment and military community transformation and a revised Unit Behavioral Health Needs Assessment tool with metrics from combat operations, non-combat operations, and garrison. Will develop a non-contact screening tool that identifies Service members at-risk for suicidal behaviors. Will evaluate a theory-based suicide screen and clinical decision-making tool that identifies at-risk Service members. Will conduct studies to develop tools to decrease suicide behaviors during key transition points of Service Members careers.			
Title: Psychological Health & Resilience - Concussion/Mild Traumatic Brain Injury Interventions ***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) in Warfighters during operations. In FY17 the work performed here will be captured in the Concussion/mTBI Interventions program. ***FY 2016 Accomplishments:*** Conducted studies to inform development of a concussion dosimeter (hardware sensor embedded with an injury prediction algorithm) working prototype to predict the likelihood of concussion based on measurements collected with sensors.	0.876	-	-
Title: Millennium Cohort Research ***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 (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. Funding for this research effort moves from Project FH2 to Project 869 starting in FY17. ***FY 2017 Plans:***	-	5.301	4.630

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will continue to evaluate the impact of military service on Warfighter and Family physical and psychological health. Specifically, will assess the long-term impact of sexual assault experiences among military men and women. Will assess the long-term health outcomes among individuals with a history of traumatic brain injury. Will examine the Performance Triad components (sleep, diet, and exercise) and association with health outcomes. Will investigate the long-term effects of military service on the risk and prevalence of cardiopulmonary (link between the cardiovascular and respiratory systems) and metabolic diseases (anomalies in the way the body processes food sources to generate energy) and continue work to identify populations with greater likelihood of utilizing Department of Veterans Affairs (VA) health services. Will continue to collect follow-up survey data on participants in the 2017-2018 survey cycle. ***FY 2018 Plans:*** Will continue to evaluate the impact of military service on Warfighter and Family physical and psychological health. Specifically, will determine factors associated with persistent and long-term mental health and evaluate factors moderating or mediating associations between service-related experiences and mental disorders. Will evaluate associations between behavioral health characteristics (e.g. physical activity, alcohol and tobacco use, and sleep hygiene) and short- and long-term outcomes among Service members and Veterans. Will establish a program to investigate chronic disease risk among Service members and Veterans. Will develop a program area focusing on environmental exposures experienced during deployments. Will evaluate the representativeness and generalizability of the Millennium Cohort Family Study and initiate a study examining the impact of family relations on the Service member spouse. Will develop a program area focusing on physical injury (traumatic and chronic) experienced during military service and mental health resilience, and establish agreements for access to objective data sources. Will initiate processing of completed 2017-2018 paper surveys.			
Title: Soldier Systems Engineering Architecture ***Description:*** This effort will advance medical science in the areas of injury prevention to optimize and performance sustainment. 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. ***FY 2016 Accomplishments:*** Advanced medical research in the areas of injury prevention and performance optimization in the context of human interaction with new Warfighter systems and provided greater insight into informing new research across the research and development community (medical and non-medical) in development of optimized Warfighter systems and the interactions between Warfighters and the systems they employ. This effort leveraged research conducted in Physiological Health, Injury Prevention & Reduction, both musculoskeletal and neurosensory, (the sensory activity or functions of the nervous system), sensory activity or functions	2.126	2.778	0.996

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
of the nervous system. Psychological Health and Resilience and Environmental Health and Protection to inform the Warfighter Systems Engineering Architecture initiative. ***FY 2017 Plans:*** Will develop bio-mathematical models and networked physiological sensor systems that accurately predict human metabolism rates, thermal strain and negative health impacts of Warfighters during physical challenges i.e. complex operational scenarios in extreme environments. These medical research tools will help prevent injuries and optimize physiological and cognitive performance of the Warfighter integrated with the new Warfighter systems. Will inform new research across the research and development community (medical and non-medical) in development of optimized systems and the interactions between the Warfighter and the systems they employ. Will leverage research in Physiological Health, Injury Prevention and Reduction, both musculoskeletal and neurosensory, Psychological Health and Resilience and Environmental Health and Protection to inform the Warfighter Systems Engineering Architecture initiative. ***FY 2018 Plans:*** Will evaluate newly developed bio-mathematical models, algorithms, and networked physiological sensor systems that accurately predict human metabolism rates, thermal strain and negative health impacts of Warfighters during physical challenges (i.e., complex operational scenarios in extreme environments). Computationally-intelligent network-capable sensors will have the ability to monitor and predict individual Warfighter physiological status (thermal, hydration, sleep status) in response to environmental conditions. Will inform new research across the research and development community in the development of optimized systems and the interactions between Warfighters and the systems they employ. Will leverage research in the Military Operational Medicine portfolio areas of Physiological Health and Protection, Injury Prevention and Reduction (both musculoskeletal and neurosensory), Psychological Health and Resilience and Environmental Health and Protection to inform the Warfighter Systems Engineering Architecture initiative.			
Accomplishments/Planned Programs Subtotals	28.717	37.409	40.201

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
870: *Dod Med Def Ag Inf Dis*	-	18.756	20.478	22.234	-	22.234	21.923	22.361	19.711	20.115	-	-

Note

In Fiscal Year (FY) 2017 the Drugs to Prevent/Treat Parasitic Diseases and Vaccines for Prevention of Malaria research areas are merged into Applied Research on drugs and vaccines against parasitic diseases.

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.

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.

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Promising medical countermeasures identified in this project are further matured under PE 0603002A, Project 810.

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

Work in this Project is performed by the Walter Reed Army Institute of Research (WRAIR), Silver Spring, MD, and its overseas laboratories; the United States (U.S.) Army Medical Research Institute of Infectious Disease (USAMRIID), Fort Detrick, MD; and the NMRC, Silver Spring, MD, and its overseas laboratories.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Drugs to Prevent/Treat Parasitic Diseases	5.304	-	-
Description: This effort conducts assessments on and improves candidate drugs coming from the DoD discovery program and from other collaborations for prevention and treatment of malaria to counter the continuing spread of drug resistance to current drugs; conducts assessments in animal models of currently available drugs for use against cutaneous leishmaniasis (a skin-based disease transmitted by sand flies); and selects the most effective and safe candidates for continued refinement and possible clinical testing. In FY17 this research area and the Vaccines for Prevention of Malaria research area are merged into one task area titled Parasitic Diseases – Drugs and Vaccines.			
FY 2016 Accomplishments: Used small animal and non-human primate testing to down-select lead candidate malaria prophylaxis (measures taken to prevent health problems) drugs based on the Triazine (six-sided ring molecule composed of 3 carbon and 3 nitrogen atoms) class of compounds. Evaluated safety and effectiveness of lead relapse curative drugs (Primaquine-like and Tafenoquine-like) in small animal models of malarias (persons getting sick a second time after drug treatment due to re-growth of parasites not eliminated during initial treatment).			
Title: Vaccines for Prevention of Malaria	4.025	-	-
Description: This effort 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. In FY17 this research area and the Drugs to Prevent/Treat Parasitic Diseases research area are merged into one task area titled Parasitic Diseases – Drugs and Vaccines.			
FY 2016 Accomplishments: Assessed mechanisms of protective immunity of new malaria protein-based vaccine candidates in small animals. Evaluated immune response of human volunteers successfully protected from infection by weakened sporozoites (infective stage of malaria parasite transmitted by mosquitoes), to discriminate protective from non-protective immune responses.			
Title: Applied Research on drugs and vaccines against parasitic diseases	-	10.179	11.902

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Description: This effort assesses and improves on candidate drugs coming from the 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 selects 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. In FY17 the Drugs to Prevent/Treat Parasitic Diseases and Vaccines for Prevention of Malaria research areas are merged into Applied Research on drugs and vaccines against parasitic diseases. ***FY 2017 Plans:*** Will use small animals to further analyze performance of a single lead candidate malaria prophylaxis (measures taken to prevent health problems) drug based on the Triazine (six-sided ring molecule composed of three carbon and three nitrogen atoms) class of compounds from initial three candidates recently evaluated in clinical trials. This initial testing will allow picking one candidate to advance, and then optimize this lead for human use. Will conduct safety testing in validated animal models in order to test reformulated and down selected compound to human trials. Will also begin studies in small animals to assess P. vivax formulated vaccine candidate for human use. Will assess formulation of new protein candidate antigens in collaboration with Glaxo SmithKline RTS,S (also known as Mosquirix (TM)) malarial vaccine platform. ***FY 2018 Plans:*** Will continue studies in validated animal models to test reformulated chemical compounds for safety and efficacy against malarias. Will continue assessment of pyramidinlyguanidine compounds (a newly discovered family of similar chemical compounds that are active against malaria parasites in experimental animals) for the treatment of malaria. Will continue assessment of primaquine-like compounds (Primaquine is an FDA-licensed drug capable of preventing relapsing malaria) for use in treatment of relapsing malarias in the monkey model. Will complete safety testing in validated animal models in order to test reformulated and down-selected vaccines against falciparum malaria (the most lethal of four types of malaria species). Will continue to evaluate new vaccine candidates against vivax malaria (the most common of four types of malaria species) in small animals.			
Title: Diagnostic Systems and Vector Identification and Control ***Description:*** This effort designs and prototypes new medical diagnostic and surveillance tools for the field, focusing on bedside and field-deployable diagnostic systems and refines interventions that protect Warfighters from biting insects such as sand flies (transmit leishmaniasis) and mosquitoes (transmit dengue, Japanese encephalitis, malaria, etc.). ***FY 2016 Accomplishments:***	1.244	1.218	1.438

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Developed tests to detect arthropod-borne pathogens for use on field deployable detection platform. Developed a multiplex assay (capable of detecting multiple pathogens at the same time). Conducted field evaluations for the rapid surveillance test to detect Chikungunya virus. ***FY 2017 Plans:*** Will develop multiplexed pathogen detection systems (capable of detecting multiple pathogens at the same time) that are cost effective, sustainable and usable to screen for priority emerging or re-emerging pathogens. These must support broad, routine surveillance programs or be focused on targeted, outbreak investigations to confirm specific pathogens. Will conduct product screening on new or existing Rapid Human Diagnostic Devices (RHDDs) that are FDA-cleared devices or devices intended to be FDA approved for the rapid (2 hours or less) diagnosis of military-relevant infectious diseases. These will be usable at Battalion Aid Station. Will develop new generation of vector repellant and control methods. Will develop spatial repellent efficacy testing protocols and systems that enable testing and development of best candidates for military use. Will develop bite-protection/ resistance testing capability for fabrics treated with repellants. ***FY 2018 Plans:*** Will develop new vector repellant and control methods. Will confirm spatial repellent efficacy testing protocols and systems that enable testing and development of best candidates for military use. Will advance the capability for fabrics treated with repellants to protect or resist against biting insects and other arthropod vectors. Will develop the multiplexed pathogen detection systems (capable of detecting multiple pathogens at the same time) that are cost effective, sustainable and usable to screen for priority emerging or re-emerging pathogens.			
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 2016 Accomplishments:*** Assessed host immune responses against dengue virus antigens among experimental vaccine recipients. Expanded vaccine test site infrastructure in selected communities at risk for dengue virus exposure. Improved methods for identification and characterization of protective antibodies. Assessed immune vaccinated or un-vaccinated and exposure risk factors among human population groups in areas where dengue exposure is historically prevalent. Assessed alternative vaccine (e.g. DNA) delivery strategies such as muscle and skin electroporation (introduction of a substance into skin and muscle by electric current), needle-free jet injection for Hantavirus vaccine. Upon success with the DNA vaccine approach, further developed additional DNA vaccines and combination vaccines against viruses-of-interest, e.g. Crimean Congo Hemorrhagic Fever). Continued investigation	3.241	3.545	3.319

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
of DNA vaccines to produce antibody products that could be used as post-exposure prophylactics (given after a subject is exposed to the disease pathogen to prevent further disease progression). ***FY 2017 Plans:*** Will assess host immune responses against dengue virus antigens among experimental vaccine recipients. Will expand vaccine test site infrastructure in selected communities at risk for dengue virus exposure. Will improve methods for identification and characterization of protective antibodies. Will assess immune vaccinated or un-vaccinated and exposure risk factors among human population groups in areas where dengue exposure is historically prevalent. Will assess alternative vaccine (e.g. DNA) delivery strategies such as muscle and skin electroporation (introduction of a substance into skin and muscle by electric current), needle-free jet injection for Hantavirus vaccine. Upon success with the DNA vaccine approach, will further develop additional DNA vaccines and combination vaccines against viruses-of-interest, e.g. Crimean Congo Hemorrhagic Fever) Will continue investigation of DNA vaccines to produce antibody products that could be used as post-exposure prophylactics (given after a subject is exposed to the disease pathogen to prevent further disease progression). ***FY 2018 Plans:*** Will further expand vaccine test site infrastructure in selected communities at risk for dengue virus exposure and support research partner efforts in testing dengue vaccine immunogenicity (ability to provoke an immune response) and effectiveness. Will continue to assess new vaccine formulations for safety and immunogenicity. Will further develop additional DNA vaccines and combination vaccines against viruses of interest, e.g. Crimean Congo Hemorrhagic Fever. Will 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, Crimean Congo Hemorrhagic Fever vaccine. Will develop an animal model of disease to test drugs and vaccines for protection against Hantavirus.			
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 2016 Accomplishments:*** Down-selected from FY15 vaccine formulations, refined and evaluated vaccine candidates against each of the three major bacterial causes of diarrhea (Shigella, enterotoxigenic E. coli and Campylobacter). Studied clinical grade (suitable for injection into human volunteers) diarrheal disease vaccine candidates in small animals for safety and effectiveness. Identified and prepared clinical trial field sites for evaluation of candidate vaccines. Maintained a chigger colony used as the challenge model to evaluate the effectiveness of Scrub typhus vaccine candidates. Studied the mechanisms of immune protection to scrub typhus. ***FY 2017 Plans:***	4.942	5.536	5.575

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
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*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will continue to refine and evaluate additional vaccine candidates against Shigella and enterotoxigenic E. coli organisms. Will continue to test these additional diarrheal vaccine candidates in small animals for the assessment of their safety and effectiveness. Will continue to identify and prepare new clinical field sites for evaluation of candidate vaccines. Will continue to maintain core capabilities in scrub typhus research. ***FY 2018 Plans:*** Will continue with the development of additional vaccine candidates against Shigella, Campylobacter and enterotoxigenic E.coli. Down-select vaccine candidates for further testing in animal models of diarrhea caused by Shigella, Campylobacter and enterotoxigenic E.coli. Will continue to test the feasibility of clinical field sites for evaluation of vaccine candidates. Will conduct studies on mechanisms of immune response to scrub typhus infection. Will maintain an animal model for scrub typhus and will characterize host-pathogen interactions in animal models.			
Accomplishments/Planned Programs Subtotals	18.756	20.478	22.234

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / *Medical Technology*	Project (Number/Name) 874 / *Cbt Casualty Care Tech*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
874: *Cbt Casualty Care Tech*	-	16.476	10.033	11.127	-	11.127	9.805	10.434	10.432	10.568	-	-

Note

In Fiscal Year (FY) 2017 the Clinical and Rehabilitative Medicine funding will move to Project ET4.

A. Mission Description and Budget Item Justification

This project refines and assesses concepts, techniques, and materiel that improve survivability and ensure improved treatment outcomes for Warfighters wounded in combat and other military operations. Combat casualty care research addresses control of severe bleeding, resuscitation and stabilization, predictive indicators and decision support technologies for life support systems , treatment of burns, and traumatic injuries to hard and soft tissues of the face, mouth, and extremities and traumatic brain injury (TBI). Clinical and rehabilitative medicine research addresses tissue repair and functional restoration including transplant technologies, for injuries to or loss of bone, muscle, skin, organ, nerve and eyes.

Research involves extensive collaboration with multiple academic institutions to refine treatments for combat wounds through 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 the following five areas:

(1) Damage Control Resuscitation
(2) Combat Trauma Therapies
(3) Combat Critical Care Engineering
(4) Clinical and Rehabilitative Medicine (moves to ET4 in FY17)
(5) Traumatic Brain Injury

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 Program Element (PE) 0603002A, Project 840.

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

Work on this project is performed by United States Army Institute of Surgical Research (USAISR), the Walter Reed Army Institute of Research (WRAIR), Silver Spring, MD; and the Armed Forces Institute of Regenerative Medicine (AFIRM), at multiple institutions across the US.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Damage Control Resuscitation	3.903	4.072	4.234

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 874 / *Cbt Casualty Care Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
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 2016 Accomplishments:*** Started animal studies to explore clinical consequences of long-term application of hemorrhage (bleeding) control products and devices. Performed animal studies leveraging FY15 work, evaluating the effectiveness of drug/blood product / fluid combinations in stopping life-threatening bleeding while maximizing the potential survival of tissues surrounding the trauma / wound site. ***FY 2017 Plans:*** As a follow on to the FY16 work, will continue to evaluate consequences of long-term application of hemorrhage control products and devices. Will evaluate novel products and approaches to treat bleeding from chest, abdominal, arm pit, and groin wounds and large, soft tissue wounds. Will assess drugs and key molecular components of blood required to optimize initial pre-hospital low volume hemostatic (acting to arrest bleeding) damage control resuscitation and tissue stabilization. ***FY 2018 Plans:*** Will conduct studies to optimize performance metrics and assays of stem cells for treatment of trauma- or infection- induced impairment of blood clotting ability. Will develop sensor technology for early assessment of blood clot strength. Will evaluate novel products and approaches, including aortic balloon occlusion, automatically operated tourniquets, and new wound packing materials, to treat bleeding from chest, abdomen, arm pit and groin wounds and large, soft tissue wounds. Will work to investigate drugs and key molecular components of blood required to optimize low volume resuscitation adjuncts to control bleeding and stabilize tissues in the pre-hospital phase of care.			
Title: Combat Trauma Therapies ***Description:*** This effort conducts research to enhance the ability to diagnose, stabilize, and accelerate wound healing and repair of damaged tissue for casualties with severe wounds to the face, mouth and extremities. ***FY 2016 Accomplishments:*** Established a quantifiable animal model of acutely (sudden onset) inflamed wounds to provide means to evaluate ability of anti-biofilm wound gel developed in FY15 along with novel products to reduce inflammation, preserve normal tissue, and prevent excessive scarring. Started animal wound healing studies using combinations of skin components to evaluate effects on wound contraction and scarring. ***FY 2017 Plans:*** Will develop and test combined agents (a bacteria-killing protein in combination with a chemical that disperses bacterial colonies) to treat contaminated facial, mouth, and extremity wounds using a quantifiable small animal model of acutely (sudden onset)	1.395	2.585	3.374

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 874 / *Cbt Casualty Care Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
inflamed wounds. Will perform studies of human, naturally occurring anti-inflammatory agents to treat uncontrolled inflammation harmful to wound healing and skin graft success after burn injury of the face and mouth area. ***FY 2018 Plans:*** Will develop preclinical wound model to examine effect of various resuscitation strategies (e.g., fluids, timing, volume) on healing of injured muscle and bone. Will continue work from FY17 to develop and test combined agents (containing agents to kill bacteria, prevent bacteria from becoming infective, and to control inflammation) to treat contaminated facial, mouth and extremity wounds.			
Title: Combat Critical Care Engineering ***Description:*** This effort refines diagnostic and therapeutic medical devices as well as associated algorithms, software, and data-processing systems for resuscitation, stabilization, life support, surgical support and preservation of vital organ function that can be applied across the pre-hospital, operational field setting, and initial definitive care facilities. ***FY 2016 Accomplishments:*** Continued studies from FY15 to identify the physiological effects of optimizing blood flow returning to the heart, as a fluidless resuscitation strategy. Completed development of first generation patient monitors using light-based sensors and integration of blood-loss prediction algorithm. Started retrospective analysis of trauma registry data to define doctrine for telehealth direction of triage and advanced resuscitation efforts by medics, and facilitate clinical practice guideline development supporting the Committee on Tactical Combat Casualty research requirements. ***FY 2017 Plans:*** Will evaluate an algorithm for prediction of need for life saving interventions in an animal model of burn injury. Will develop a severe injury animal model to evaluate closed loop and automated resuscitation systems (medical devices that automatically provide treatment to the patient based on physiological changes without direct input from care provider). Will model the physiology of extracorporeal life support devices (devices that oxygenate and purify the blood outside of the body) in conjunction with different modes of mechanical ventilation. Will evaluate technologies to reduce preventable deaths from difficult airway management. ***FY 2018 Plans:*** Will study means 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 allows normal blood clotting to occur in the patient. Will continue work from FY17 to validate treatment algorithms in animal burn injury model. Will continue work from FY17 to validate technologies to reduce preventable deaths due to difficult airway management.	1.993	1.417	1.476
Title: Clinical and Rehabilitative Medicine ***Description:*** This effort conducts laboratory and animal studies to better understand mechanisms of regenerating and restoring traumatically-injured tissues of skin, muscle, nerve, bone tissue, and soft tissue (e.g. skin and muscle, including the genitalia and	6.993	-	-

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 874 / *Cbt Casualty Care Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
abdomen) as well as studies regarding ocular (eye) and visual system traumatic injury for the care and treatment of battle-injured casualties. In FY17 this effort moves to Project ET4. ***FY 2016 Accomplishments:*** Down-selected and developed drug delivery, diagnostic, tissue repair, and treatment strategies including drugs and stem cell therapies for eye trauma to determine the best candidates to advance to safety and efficacy preclinical trials. Evaluated candidate strategies for burn injury, bone and soft tissue repair, and strategies to address injury to the extremities, face, genital, and abdominal regions. Performed studies to determine the applicability of using cell-based therapies (e.g. stem cells) to repair or restore skin, testicular, muscle, and bone tissues and advance lead technologies to preclinical safety and efficacy studies. Continued studies in animal models of improved life support technologies for treatment of single and multiple organ failure.			
Title: Traumatic Brain Injury ***Description:*** This effort supports refinement of drug (includes mature drug technologies; 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. ***FY 2016 Accomplishments:*** Down-selected candidate drugs and other treatment strategies for treatment of TBI. Characterize polytrauma (multiple trauma injuries)/TBI animal models to develop potential TBI drug treatments. Characterized the brain tissue neuroplasticity (ability of the nervous system to adapt to injury) to enhance and exploit that potential in treatment strategies for greater functional recovery from TBI. ***FY 2017 Plans:*** Will examine the correlation of neuroplasticity (ability of the nervous system to adapt to injury) markers to changes in neural cell connections and growth during recovery from TBI. Will conduct studies to determine key molecular targets for neural cell protection and brain tissue regeneration following brain injury. ***FY 2018 Plans:*** Will use data from neuroplasticity (ability of the nervous system to adapt to injury) marker studies to refine current animal models of military relevant brain injury to support studies of TBI treatments that work by affecting the injured brain's ability to use energy and repair itself. Will refine animal models of acute, severe TBI in combination with severe bleeding and lung and other vital organ injuries for evaluation of neurotherapeutic (therapies to protect brain tissue from further damage following a TBI event) resuscitation strategies for treatment of TBI and hemorrhagic (bleeding) shock.	2.192	1.959	2.043
Accomplishments/Planned Programs Subtotals	16.476	10.033	11.127

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 874 / *Cbt Casualty Care Tech*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / *Medical Technology*	Project (Number/Name) ET4 / *Appl Resch in Clinical and Rehabilitative Medicine*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
ET4: *Appl Resch in Clinical and Rehabilitative Medicine*	-	0.000	7.273	7.871	-	7.871	12.335	11.143	9.314	9.229	-	-

Note

In Fiscal Year (FY) 2017 the Clinical and Rehabilitative Medicine funding will move from Project 874 to Project ET4.

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 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 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 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 Program Element (PE) 0603002A, Project ET5.

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

Work on this Project is performed by United States Army Institute of Surgical Research (USAISR), Joint Base San Antonio, TX; and the AFIRM, at Multiple Institutions across the United States.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Clinical and Rehabilitative Medicine	-	7.273	7.871
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. This research moved from Project 874 to Project ET4 starting in FY17.			
FY 2017 Plans:			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** ET4 / *Appl Resch in Clinical and Rehabilitative Medicine*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will conduct pre-clinical screening, down-selection and further development of drug delivery, diagnostics, tissue repair, and treatment strategies including drugs and stem cell therapies for eye trauma. Will advance therapeutic and treatment strategies for eye injuries to safety and efficacy preclinical trials. Will further evaluate promising candidate strategies for burn injury, bone and soft tissue repair, and therapies that address injury to the extremities, face, genital and abdominal body regions. Will evaluate advanced cell-based therapies (e.g. stem cells) that repair or restore skin, testicular, muscle, and bone tissues in animal models. Will further develop novel immunomodulation (modification of the immune response / immune system functioning) technologies and strategies to improve outcomes in hand and face transplant procedures. Will further develop improved vascular technologies that reduce the requirement for vein harvest. ***FY 2018 Plans:*** Will optimize preclinical design of a novel ocular medical device designed to deliver therapeutics, protect, and preserve vision post-injury. Will establish the effects of treatment of up to three promising pharmaceuticals designed to restore vision in the scarred eye after injury for down selection. Will conduct pre-clinical safety and efficacy testing of an eye bandage with therapeutics to optimize vision restoration post-injury. Will evaluate methods for enhancing skin substitute performance for improvement of skin function following burns and loss from trauma. Will examine pharmacologic (drug) treatments to prevent scarring from deep partial-thickness burns. Will establish effectiveness of treatment methodologies for large volume muscle loss to restore muscle form and function. Will develop devices and biologics for regeneration or restoration of genitourinary (genital and urinary) tissues lost or damaged due to traumatic injury.			
Accomplishments/Planned Programs Subtotals	-	7.273	7.871

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army											Date: May 2017	
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602787A / *Medical Technology*				Project (Number/Name) FH2 / *Force Health Protection - Applied Research*			
COST ($ in Millions)	**Prior Years**	**FY 2016**	**FY 2017**	**FY 2018 Base**	**FY 2018 OCO**	**FY 2018 Total**	**FY 2019**	**FY 2020**	**FY 2021**	**FY 2022**	**Cost To Complete**	**Total Cost**
FH2: *Force Health Protection - Applied Research*	-	5.094	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-

Note

Starting in Fiscal Year (FY) 2017 Project FH2 (Force Health Protection – Applied Research) funding and research efforts will move into Project 869 (Warfighter Health Protection and Performance Standards).

A. Mission Description and Budget Item Justification

This Project conducts research to support applied research directed toward the sustainment of a healthy Warfighters from accession through retirement. This research focuses on enhanced protection of Warfighters against health threats in military operations and training. Stressors that adversely affect individual Warfighter health readiness are identified and studied to refine interventions that will protect Warfighters and improve their health and performance in stressful environments. This is follow-on research that extends and applies findings from over a decade of research on Gulf War Illnesses and other chronic multi-symptom illnesses that have suspected nerve and behavioral alterations caused by environmental contaminants and deployment stressors. Key databases include the Millennium Cohort Study and the Total Army Injury and Health Outcomes Database. These databases allow us to evaluate interactions of psychological stress and other deployment and occupational stressors that affect Warfighter health behaviors.

Force Health Protection applied research is conducted in close coordination with the Department of Veterans Affairs. This Project contains no duplication with any effort within the Military Departments and includes direct participation by other Services working on Army Projects.

Research conducted in this project focuses on the following three areas:
(1) Millennium Cohort Research
(2) Biomarkers of Exposure and Environmental Biomonitoring
(3) Physiological Response and Blast and Blunt Trauma Models of Thoracic (Chest) and Pulmonary (Lung) Injuries
Promising efforts identified in this project are further matured under Program Element 0603002A, Project FH4.

The cited work is consistent with the Assistant 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 Center for Environmental Health Research (USACEHR), Fort Detrick, MD; the Naval Health Research Center (NHRC), San Diego, CA; and the United States Army Research Institute of Environmental Medicine (USARIEM), Natick, MA.
Efforts in this project support the Soldier Portfolio and the principal area of Combat Casualty Care.

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** FH2 / *Force Health Protection - Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Millennium Cohort Research ***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 (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 Warfighters. Funding moved to Project 869 in FY17. ***FY 2016 Accomplishments:*** Continue the FY15 evaluation of the impact of child health on Family functioning and Warfighter health outcomes and investigate the impact of the Family's response to deployment on the mental health of the deployed Service Member. Finalize survey data collection on new and follow-up Millennium Cohort enrollees, and begin the process of detecting, correcting and removing corrupt entries in the survey data (2014-2015 survey cycle). Evaluate long-term functional and physical health of early cohort deployed Service Member. Assess negative coping behaviors such as misuse of alcohol and tobacco use in Warfighter cohorts and likelihood of utilizing Department of Veterans Affairs (VA) health services.	4.612	-	-
Title: Physiological Response and Blast and Blunt Trauma Models of Thoracic (Chest) and Pulmonary (Lung) Injury ***Description:*** This effort supports modeling and assessment of the combined effects of blast, impact, and ballistic trauma on the chest and lung system. Funding moved to Project 869 in FY17 (Concussion/Mild Traumatic Brain Injury (mTBI) Interventions). ***FY 2016 Accomplishments:*** Refine performance models developed in FY15 that assessed endurance for military relevant tasks including algorithm development to predict musculoskeletal adaptations to fatigue. Refine biomechanical performance models developed in FY15, to incorporate military relevant tasks, such as lifting and marksmanship that use the upper body and core.	0.482	-	-
Accomplishments/Planned Programs Subtotals	5.094	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** FH2 / *Force Health Protection - Applied Research*

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army			Date: May 2017
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / *Medical Technology*	Project (Number/Name) VB4 / *System Biology And Network Science Technology*	

COST ($ in Millions)	Prior Years	FY 2016	FY 2017	FY 2018 Base	FY 2018 OCO	FY 2018 Total	FY 2019	FY 2020	FY 2021	FY 2022	Cost To Complete	Total Cost
VB4: *System Biology And Network Science Technology*	-	5.143	1.918	2.001	-	2.001	2.075	2.116	2.171	2.215	-	-

Note

Starting in Fiscal Year (FY) 2017 the toxic substances research efforts and funding will move from Project VB4 (System Biology And Network Science Technology) into Project 869.

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 (PTSD) Project) have been shown to reduce both the time and expense of medical product development for the Army

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

Work in this Project is performed by the United States Army Medical Research and Materiel Command (USAMRMC), Fort Detrick, MD / United States Army Center for Environmental Health Research (USACEHR).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Title: Systems Biology	5.143	1.918	2.001
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 to diseases of military relevance. Applied research is being			

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** VB4 / *System Biology And Network Science Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018

conducted to identify biological networks that are causative of illness in Post-Traumatic Stress Disorder (PTSD) and co-morbidities (presence of one or more diseases or disorders), coagulopathy (impaired ability to clot blood) of trauma, Traumatic Brain Injury, pain, suicide, infectious disease, and immune responses. In particular, the studies of PTSD are directed to refine biomarkers for screening, early diagnosis and therapeutic target discovery. Applied research is also aimed to identify (the substance itself and how it causes harm) toxic substances, e.g., toxic industrial chemicals. The molecular and physiological markers of intoxication are then applied to support diagnostic tools development of medical countermeasures. The task funding for the toxic substances research effort moves to Project 869 in FY17.

FY 2016 Accomplishments:

Improved and applied tools in the SysBioCube (USAMRMC's information management suite, hosted by the National Cancer Institute (NCI)/National Institutes of Health (NIH) via the Frederick National Laboratory for Cancer Research (FNLCR)) to begin to define unique molecular patterns / signatures related to suicidality (suicidal tendencies), coagulopathy, and chronic pain. Evaluatee and modeled molecular data from PTSD clinical studies to further define signatures within PTSD sufferers into distinct subgroups. Further refined and established PTSD diagnostic biomarkers, to improve therapeutic drug effectiveness and support therapeutic drug discovery. Used PTSD biomarker in animal models to verify new therapeutic drug targeting. Constructed a laboratory developed test (LDT) for PTSD using commercial off-the-shelf technology, and evaluated it in selected medical treatment facilities; continued to advance tests for identification of subgroups of PTSD to aid in informing appropriate therapeutic approaches and pursue FDA approval. Began the design of tests for future diagnostic capabilities that would permit simultaneous measurement of multiple organ specific biomarkers indicative of exposure to a toxic substance.

FY 2017 Plans:

Will continue to expand Systems Biology (SB) scientific efforts and to facilitate collaborative partnerships with Army, Department of Defense (DoD) and extramural laboratories. Will continue overseeing data sharing and data integration activities and continue to expand the SysBioCube capabilities to accommodate usage growth and integration of large, complex data sets. For coagulopathy, will complete the collection of time-course samples from trauma patients and proceed to determine the molecular effects of various clinical treatments to improve (or not) the clinical status. Will conduct data analyses of findings with chronic pain, suicidality, infection and effects of microgravity (functions as a stressor) to integrate with clinical results. Will evaluate nutritional supplements in the mouse model simulating features of PTSD in order to assess improved resolution or recovery. Will integrate clinical and multi-molecular studies of PTSD in humans to confirm a candidate panel(s) to diagnose chronic PTSD for advancement to a LDT which will be confirmed by a commercial lab; will identify three to four DoD clinical sites which will have the facilities to evaluate the LDT as a precursor for moving forward with an FDA product. Will evaluate clinical trials using standard PTSD therapy regimens to determine which aspects of PTSD are improved (or not) and to begin to associate initial status of the patients in order to inform therapeutic strategies 'personalized' for the individual's condition.

FY 2018 Plans:

Exhibit R-2A, RDT&E Project Justification: FY 2018 Army		Date: May 2017
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** VB4 / *System Biology And Network Science Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2016	FY 2017	FY 2018
Will expand Systems Biology capabilities, to facilitate collaborative intramural and extramural partnerships, and to accommodate an expected increase in the number of end-users of the SysBioCube (USAMRMC's information management suite, hosted by the NCI / NIH via the Frederick National Laboratory for Cancer Research). Will oversee data sharing and data integration of large, complex datasets. Will increase capabilities to develop novel methods that integrate different systems biology data (e.g., genetics and metabolism data) that, in turn, will lead to new knowledge products. Will provide support to the Integrative Systems Biology Program at USACEHR for oversight of research efforts. Time-dependent clinical data collections and integrated omics analyses of treatment efficacies will be used in a wide range of studies including biomarker development and the understanding the altered molecular mechanisms that underlie PTSD, coagulopathy (blood's ability to form clot is impaired), chronic pain perception, infectious diseases, and micro-gravitational stress on bone. Will build a data-repository capability within the SysBioCube that will initially be for publications and associated datasets from 6.1 (Basic Research)-funded intramural research.			
Accomplishments/Planned Programs Subtotals	5.143	1.918	2.001

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A