Department of Defense
Fiscal Year (FY) 2017 President's Budget Submission

February 2016

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, $7,615,921,000.00 to remain available for obligation until September 30, 2018.

The following Justification Books were prepared at a cost of $1,209,553: 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 2017 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 2017.

2. **Relationship of the FY 2017 Budget Submitted to Congress to the FY 2016 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:

PE/Project	PE Title	Project Title
345251/FA8	Cyberspace Operations Forces and Force Support	Cyberspace Operations Forces and Force Support
363326/FA9	Security Initiatives	Security Initiatives
373150/EA5	Army Global Command & Control System	Strategic and Joint Mission Command
643308/EB7	Army Missile Defense Systems Integration	Army Space System Enhancement/Integration
643619/606	Close Combat Systems Adv Dev	Cntrmn/Barrier Adv Dev
643801/B47	Aviation Advanced Development	Future Vertical Lift Medium
654270/ET7	EW Development	Radio Frequency Interference Mitigation
654270/DX6	EW Development	Radio Frequency Interference Mitigation
654622/659	Family of Heavy Tactical Vehicles	Family of Hvy Tac Veh
654622/E40	Light Tactical Wheeled Vehicle	LTV Prototype
654645/EV8	Armored Systems Modernization on End Dev	Mobile Protected Firepower
654818/EW3	Army Tac Comm & Cont Hardware & Software	Unit Task Reorganization (UTR) Development
654822/EV4	General Fund Enterprise Business System (GFEBS)	General Fund Enterprise Business System Inc 2
664759/FA4	Major Test & Evaluation Investment	Warrior Injury Assessment Manikin (WIAMan)
675024/FB1	Anti-Tamper Technology Support	Anti-Tamper Technology Support
654818/EW3	Army Tac Comm &Cont Hardware & Software	Unit Task Reorganization (UTR) Development

B. Program Element/Project Restructures:

Old PE/Project	New Project Title	New PE/Project
0205778/EG2	Long Range Precision Fires (LRPF)	0607134/ES1
0303140/501	Army Key Mgmt System	0303140/DV4
0305204/D10	MQ-1C Gray Eagle	0203744/EB6
0601102/S14	Basic Resch in Clinical & Rehabilitative Med	0601102/ET6
0602787/874	Appl Resch in Clinical and Rehabilitative Med	0602787/ET4
0603002/840	Medical Advance Technology	0603002/ET5
0603827/S53	Personnel Airdrop System Development	0603827/ET8
0604120/ED5	Mounted	0604120/EH8
0604120/ED5	Dismounted	0604120/EJ2
0604280/DZ5	Manpack Radio	0605042/FA1
0604280/DZ5	Rifleman Radio	0605042/FA2
0604622/659	TWV Protection Kits	0604622/VR5
0604759/984	Range Radar Replacement Program (RRRP)	0604759/EY9
0604798/DY4	Network Integration Support	0604798/DY3
0604798/DY6	Brigade and Platform Integration Support	0604798/DY3
0604818/S75	Tactical Network Operations and Management	0604818/EK9
0604827/S75	Ground Soldier Ensemble	0604818/EQ8
0605031/EF5	Waveforms	0605031/EX6
0605457/DU4	FAAD C2 ED	0604741/126

C. Developmental Transitions:

Old PE/Project	New Project Title	New PE/Project
0204502/EF2	Integ/GrdSecSurv RespC	0605029/EQ2
0204502/EF2	Grnd-Based Opnl Surv Sys Expend (GBOSS-E)	0605033/EQ3
0303140/491	Defensive Cyber Operations	0605041/EV5
0603639/EC2	Adv Armor-Piercing (ADVAP)	0604802/EP5
0603639/EL8	Lightweight Cartridge Case for Small Caliber Ammo	0604802/EP6
0603639/656	120mm Cartridge (Advanced Multipurpose AMP)	0604802/ED7
0603782/372	Warfighter Information Network	0605535/EE8
0603827S54	Crew Served Weapons Engineering Development	0604601/EW4
0603850/472	Integrated Broadcast System	0305179/EF4
0605626/AC5	Enhanced Medium Alt Recon Surv Sys	0305206/EH3
0605898/M65	ATEC Joint	0605712/001
0606801/M46	AMCOM Cmd/Ctr Spt	0602705/H94
0606801/M46	AMCOM Cmd/Ctr Spt	0605024/FB1
0607865/DV8	Lower Tier Missile Defense (LTAMD) Capability	0604114/EX2
0604319/DU3	IFPC2	0605052/EY7

D. Program Terminations:

PE Title	PE/Project
Aircrew Integrated Sys Ad	0603827/152
PAC-3/MSE Missile	0605456/PA3

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.

Department of Defense
FY 2017 President's Budget
Exhibit R-1 FY 2017 President's Budget
Total Obligational Authority
(Dollars in Thousands)

14 Jan 2016

Appropriation	FY 2015 (Base & OCO)	FY 2016 Base Enacted	FY 2016 OCO Enacted	FY 2016 Total Enacted	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Research, Development, Test & Eval, Army	6,744,134	7,562,170	1,500	7,563,670	7,515,399	100,522	7,615,921
Total Research, Development, Test & Evaluation	6,744,134	7,562,170	1,500	7,563,670	7,515,399	100,522	7,615,921

Department of Defense
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Summary Recap of Budget Activities	FY 2015 (Base & OCO)	FY 2016 Base Enacted	FY 2016 OCO Enacted	FY 2016 Total Enacted	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Basic Research	447,868	469,079		469,079	428,943		428,943
Applied Research	964,085	1,092,885		1,092,885	907,574		907,574
Advanced Technology Development	1,089,087	1,127,304		1,127,304	930,065		930,065
Advanced Component Development & Prototypes	298,467	506,123	1,500	507,623	550,635	9,375	560,010
System Development & Demonstration	1,604,756	2,085,147		2,085,147	2,265,094	84,043	2,349,137
RDT&E Management Support	1,166,015	1,070,581		1,070,581	1,136,134		1,136,134
Operational Systems Development	1,173,856	1,211,051		1,211,051	1,296,954	7,104	1,304,058
Total Research, Development, Test & Evaluation	6,744,134	7,562,170	1,500	7,563,670	7,515,399	100,522	7,615,921
Summary Recap of FYDP Programs							
General Purpose Forces	705,451	779,716		779,716	618,038		618,038
Intelligence and Communications	162,187	171,857		171,857	238,711	7,104	245,815
Research and Development	5,788,542	6,545,639	1,500	6,547,139	6,591,738	93,418	6,685,156
Central Supply and Maintenance	73,419	60,422		60,422	62,287		62,287
Administration and Associated Activities	233						
Classified Programs	14,302	4,536		4,536	4,625		4,625
Total Research, Development, Test & Evaluation	6,744,134	7,562,170	1,500	7,563,670	7,515,399	100,522	7,615,921

R-1C1: FY 2017 President's Budget (Published Version of PB Position), as of January 14, 2016 at 10:17:52

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

Line No	Program Element Number	Item	Act	FY 2015 (Base & OCO)	FY 2016 Base Enacted	FY 2016 OCO Enacted	FY 2016 Total Enacted	FY 2017 Base	FY 2017 OCO	FY 2017 Total	Sec
1	0601101A	In-House Laboratory Independent Research	01	13,125	13,018		13,018	12,381		12,381	U
2	0601102A	Defense Research Sciences	01	249,855	279,118		279,118	253,116		253,116	U
3	0601103A	University Research Initiatives	01	79,122	72,603		72,603	69,166		69,166	U
4	0601104A	University and Industry Research Centers	01	105,766	104,340		104,340	94,280		94,280	U
	Basic Research			447,868	469,079		469,079	428,943		428,943	
5	0602105A	Materials Technology	02	45,563	68,314		68,314	31,533		31,533	U
6	0602120A	Sensors and Electronic Survivability	02	45,792	58,374		58,374	36,109		36,109	U
7	0602122A	TRACTOR HIP	02	16,358	6,879		6,879	6,995		6,995	U
8	0602211A	Aviation Technology	02	62,046	56,884		56,884	65,914		65,914	U
9	0602270A	Electronic Warfare Technology	02	19,333	19,243		19,243	25,466		25,466	U
10	0602303A	Missile Technology	02	61,144	53,553		53,553	44,313		44,313	U
11	0602307A	Advanced Weapons Technology	02	37,464	38,028		38,028	28,803		28,803	U
12	0602308A	Advanced Concepts and Simulation	02	26,505	27,862		27,862	27,688		27,688	U
13	0602601A	Combat Vehicle and Automotive Technology	02	71,811	98,439		98,439	67,959		67,959	U
14	0602618A	Ballistics Technology	02	83,610	117,801		117,801	85,436		85,436	U
15	0602622A	Chemical, Smoke and Equipment Defeating Technology	02	3,865	3,866		3,866	3,923		3,923	U
16	0602623A	Joint Service Small Arms Program	02	6,633	5,487		5,487	5,545		5,545	U
17	0602624A	Weapons and Munitions Technology	02	62,131	83,340		83,340	53,581		53,581	U
18	0602705A	Electronics and Electronic Devices	02	72,442	64,301		64,301	56,322		56,322	U

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19	0602709A	Night Vision Technology	02	44,694	38,807		38,807	36,079		36,079	U
20	0602712A	Countermine Systems	02	28,597	36,568		36,568	26,497		26,497	U
21	0602716A	Human Factors Engineering Technology	02	23,434	23,681		23,681	23,671		23,671	U
22	0602720A	Environmental Quality Technology	02	15,288	20,850		20,850	22,151		22,151	U
23	0602782A	Command, Control, Communications Technology	02	33,117	36,160		36,160	37,803		37,803	U
24	0602783A	Computer and Software Technology	02	10,514	12,656		12,656	13,811		13,811	U
25	0602784A	Military Engineering Technology	02	66,582	80,909		80,909	67,416		67,416	U
26	0602785A	Manpower/Personnel/Training Technology	02	21,280	24,735		24,735	26,045		26,045	U
27	0602786A	Warfighter Technology	02	31,597	39,295		39,295	37,403		37,403	U
28	0602787A	Medical Technology	02	74,285	76,853		76,853	77,111		77,111	U
		Applied Research		964,085	1,092,885		1,092,885	907,574		907,574	
29	0603001A	Warfighter Advanced Technology	03	75,833	55,973		55,973	38,831		38,831	U
30	0603002A	Medical Advanced Technology	03	104,997	108,584		108,584	68,365		68,365	U
31	0603003A	Aviation Advanced Technology	03	99,762	103,136		103,136	94,280		94,280	U
32	0603004A	Weapons and Munitions Advanced Technology	03	72,176	82,663		82,663	68,714		68,714	U
33	0603005A	Combat Vehicle and Automotive Advanced Technology	03	143,606	135,571		135,571	122,132		122,132	U
34	0603006A	Space Application Advanced Technology	03	6,664	5,554		5,554	3,904		3,904	U
35	0603007A	Manpower, Personnel and Training Advanced Technology	03	11,677	12,636		12,636	14,417		14,417	U

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36	0603008A	Electronic Warfare Advanced Technology	03	43,416							U
37	0603009A	TRACTOR HIKE	03	7,492	7,502		7,502	8,074		8,074	U
38	0603015A	Next Generation Training & Simulation Systems	03	16,103	17,425		17,425	18,969		18,969	U
39	0603020A	TRACTOR ROSE	03	14,483	11,912		11,912	11,910		11,910	U
40	0603125A	Combating Terrorism - Technology Development	03	23,334	33,520		33,520	27,686		27,686	U
41	0603130A	TRACTOR NAIL	03	3,440	2,381		2,381	2,340		2,340	U
42	0603131A	TRACTOR EGGS	03	2,406	2,431		2,431	2,470		2,470	U
43	0603270A	Electronic Warfare Technology	03	27,238	32,874		32,874	27,893		27,893	U
44	0603313A	Missile and Rocket Advanced Technology	03	78,302	104,449		104,449	52,190		52,190	U
45	0603322A	TRACTOR CAGE	03	11,105	10,999		10,999	11,107		11,107	U
46	0603461A	High Performance Computing Modernization Program	03	214,614	222,159		222,159	177,190		177,190	U
47	0603606A	Landmine Warfare and Barrier Advanced Technology	03	12,795	13,966		13,966	17,451		17,451	U
48	0603607A	Joint Service Small Arms Program	03	7,055	5,105		5,105	5,839		5,839	U
49	0603710A	Night Vision Advanced Technology	03	46,056	40,929		40,929	44,468		44,468	U
50	0603728A	Environmental Quality Technology Demonstrations	03	11,311	14,727		14,727	11,137		11,137	U
51	0603734A	Military Engineering Advanced Technology	03	17,124	26,845		26,845	20,684		20,684	U
52	0603772A	Advanced Tactical Computer Science and Sensor Technology	03	38,098	38,147		38,147	44,239		44,239	U

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53	0603794A	C3 Advanced Technology	03		37,816		37,816	35,775		35,775	U
		Advanced Technology Development		1,089,087	1,127,304		1,127,304	930,065		930,065	
54	0603305A	Army Missle Defense Systems Integration	04	25,672	29,347		29,347	9,433		9,433	U
55	0603308A	Army Space Systems Integration	04	13,804	25,061		25,061	23,056	9,375	32,431	U
56	0603619A	Landmine Warfare and Barrier - Adv Dev	04		45,757		45,757	72,117		72,117	U
57	0603627A	Smoke, Obscurant and Target Defeating Sys-Adv Dev	04		13,426		13,426	28,244		28,244	U
58	0603639A	Tank and Medium Caliber Ammunition	04	25,317	46,749		46,749	40,096		40,096	U
59	0603747A	Soldier Support and Survivability	04	8,633	2,801	1,500	4,301	10,506		10,506	U
60	0603766A	Tactical Electronic Surveillance System - Adv Dev	04	9,255	13,472		13,472	15,730		15,730	U
61	0603774A	Night Vision Systems Advanced Development	04	3,521	7,292		7,292	10,321		10,321	U
62	0603779A	Environmental Quality Technology - Dem/Val	04	7,529	8,813		8,813	7,785		7,785	U
63	0603790A	NATO Research and Development	04	2,839	6,075		6,075	2,300		2,300	U
64	0603801A	Aviation - Adv Dev	04					10,014		10,014	U
65	0603804A	Logistics and Engineer Equipment - Adv Dev	04	13,188	21,233		21,233	20,834		20,834	U
66	0603807A	Medical Systems - Adv Dev	04	22,825	31,962		31,962	33,503		33,503	U
67	0603827A	Soldier Systems - Advanced Development	04	9,194	22,994		22,994	31,120		31,120	U
68	0604100A	Analysis Of Alternatives	04	9,685	9,805		9,805	6,608		6,608	U

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69	0604114A	Lower Tier Air Missile Defense (LTAMD) Sensor	04					35,132		35,132	U
70	0604115A	Technology Maturation Initiatives	04	43,083	35,917		35,917	70,047		70,047	U
71	0604120A	Assured Positioning, Navigation and Timing (PNT)	04	11,447	30,058		30,058	83,279		83,279	U
72	0604319A	Indirect Fire Protection Capability Increment 2-Intercept (IFPC2)	04	92,475	155,361		155,361				U
73	0305251A	Cyberspace Operations Forces and Force Support	04					40,510		40,510	U
		Advanced Component Development & Prototypes		298,467	506,123	1,500	507,623	550,635	9,375	560,010	
74	0604201A	Aircraft Avionics	05	39,583	18,639		18,639	83,248		83,248	U
75	0604270A	Electronic Warfare Development	05	5,792	18,843		18,843	34,642		34,642	U
76	0604280A	Joint Tactical Radio	05	9,454	4,546		4,546				U
77	0604290A	Mid-tier Networking Vehicular Radio (MNVR)	05	9,355	8,763		8,763	12,172		12,172	U
78	0604321A	All Source Analysis System	05	5,532	4,309		4,309	3,958		3,958	U
79	0604328A	TRACTOR CAGE	05	19,929	15,138		15,138	12,525		12,525	U
80	0604601A	Infantry Support Weapons	05	36,826	89,661		89,661	66,943		66,943	U
81	0604604A	Medium Tactical Vehicles	05	202							U
82	0604611A	JAVELIN	05	4,006	3,945		3,945	20,011		20,011	U
83	0604622A	Family of Heavy Tactical Vehicles	05	12,768				11,429		11,429	U
84	0604633A	Air Traffic Control	05	17,066	10,076		10,076	3,421		3,421	U
85	0604641A	Tactical Unmanned Ground Vehicle (TUGV)	05	2,663	15,374		15,374	39,282		39,282	U

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86	0604642A	Light Tactical Wheeled Vehicles	05					494		494	U
87	0604645A	Armored Systems Modernization (ASM) - Eng Dev	05					9,678		9,678	U
88	0604710A	Night Vision Systems - Eng Dev	05	58,997	67,582		67,582	84,519		84,519	U
89	0604713A	Combat Feeding, Clothing, and Equipment	05	2,983	1,763		1,763	2,054		2,054	U
90	0604715A	Non-System Training Devices - Eng Dev	05	8,775	27,155		27,155	30,774	33	30,807	U
91	0604741A	Air Defense Command, Control and Intelligence - Eng Dev	05	15,294	34,569		34,569	53,332		53,332	U
92	0604742A	Constructive Simulation Systems Development	05	4,394	23,364		23,364	17,887		17,887	U
93	0604746A	Automatic Test Equipment Development	05	10,685	8,960		8,960	8,813		8,813	U
94	0604760A	Distributive Interactive Simulations (DIS) - Eng Dev	05	9,699	9,138		9,138	10,487		10,487	U
95	0604780A	Combined Arms Tactical Trainer (CATT) Core	05	33,422	21,622		21,622	15,068		15,068	U
96	0604798A	Brigade Analysis, Integration and Evaluation	05	82,957	99,242		99,242	89,716		89,716	U
97	0604802A	Weapons and Munitions - Eng Dev	05	17,312	21,379		21,379	80,365		80,365	U
98	0604804A	Logistics and Engineer Equipment - Eng Dev	05	23,652	46,039		46,039	75,098		75,098	U
99	0604805A	Command, Control, Communications Systems - Eng Dev	05	5,116	2,683		2,683	4,245		4,245	U
100	0604807A	Medical Materiel/Medical Biological Defense Equipment - Eng Dev	05	29,441	45,412		45,412	41,124		41,124	U
101	0604808A	Landmine Warfare/Barrier - Eng Dev	05	53,579	55,215		55,215	39,630		39,630	U

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Line No	Program Element Number	Item	Act	FY 2015 (Base & OCO)	FY 2016 Base Enacted	FY 2016 OCO Enacted	FY 2016 Total Enacted	FY 2017 Base	FY 2017 OCO	FY 2017 Total	Sec
102	0604818A	Army Tactical Command & Control Hardware & Software	05	29,690	131,639		131,639	205,590		205,590	U
103	0604820A	Radar Development	05	5,022	12,309		12,309	15,983		15,983	U
104	0604822A	General Fund Enterprise Business System (GFEBS)	05	5,500	21,155		21,155	6,805		6,805	U
105	0604823A	Firefinder	05	22,587	2,967		2,967	9,235		9,235	U
106	0604827A	Soldier Systems - Warrior Dem/Val	05	5,942	18,776		18,776	12,393		12,393	U
107	0604854A	Artillery Systems - EMD	05	1,838	1,953		1,953	1,756		1,756	U
108	0605013A	Information Technology Development	05	64,982	60,358		60,358	74,236		74,236	U
109	0605018A	Integrated Personnel and Pay System-Army (IPPS-A)	05	62,831	121,011		121,011	155,584		155,584	U
110	0605028A	Armored Multi-Purpose Vehicle (AMPV)	05	88,797	226,210		226,210	184,221		184,221	U
111	0605029A	Integrated Ground Security Surveillance Response Capability (IGSSR-C)	05					4,980		4,980	U
112	0605030A	Joint Tactical Network Center (JTNC)	05	8,615	13,357		13,357	15,041		15,041	U
113	0605031A	Joint Tactical Network (JTN)	05	17,305	18,055		18,055	16,014		16,014	U
114	0605032A	TRACTOR TIRE	05		5,677		5,677	27,254		27,254	U
115	0605033A	Ground-Based Operational Surveillance System - Expeditionary (GBOSS-E)	05					5,032		5,032	U
116	0605034A	Tactical Security System (TSS)	05					2,904		2,904	U
117	0605035A	Common Infrared Countermeasures (CIRCM)	05	169,196	101,570		101,570	96,977	10,900	107,877	U
118	0605036A	Combating Weapons of Mass Destruction (CWMD)	05					2,089		2,089	U

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119	0605041A	Defensive CYBER Tool Development	05					33,836		33,836	U
120	0605042A	Tactical Network Radio Systems (Low-Tier)	05					18,824		18,824	U
121	0605047A	Contract Writing System	05					20,663		20,663	U
122	0605051A	Aircraft Survivability Development	05		78,112		78,112	41,133	73,110	114,243	U
123	0605052A	Indirect Fire Protection Capability Inc 2 - Block 1	05					83,995		83,995	U
124	0605350A	WIN-T Increment 3 - Full Networking	05	108,851	33,515		33,515				U
125	0605380A	AMF Joint Tactical Radio System (JTRS)	05	6,616	11,455		11,455	5,028		5,028	U
126	0605450A	Joint Air-to-Ground Missile (JAGM)	05	80,585	83,054		83,054	42,972		42,972	U
127	0605456A	PAC-3/MSE Missile	05	33,709	2,272		2,272				U
128	0605457A	Army Integrated Air and Missile Defense (AIAMD)	05	147,250	222,075		222,075	252,811		252,811	U
129	0605625A	Manned Ground Vehicle	05	47,265	39,247		39,247				U
130	0605626A	Aerial Common Sensor	05	20,328	2		2				U
131	0605766A	National Capabilities Integration (MIP)	05	18,254	10,599		10,599	4,955		4,955	U
132	0605812A	Joint Light Tactical Vehicle (JLTV) Engineering and Manufacturing Development Ph	05	43,302	32,486		32,486	11,530		11,530	U
133	0605830A	Aviation Ground Support Equipment	05	9,655	13,880		13,880	2,142		2,142	U
134	0210609A	Paladin Integrated Management (PIM)	05	77,210	152,288		152,288	41,498		41,498	U
135	0303032A	TROJAN - RH12	05	983	5,022		5,022	4,273		4,273	U

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136	0304270A	Electronic Warfare Development	05	8,961	12,686		12,686	14,425		14,425	U
		System Development & Demonstration		1,604,756	2,085,147		2,085,147	2,265,094	84,043	2,349,137	
137	0604256A	Threat Simulator Development	06	21,691	27,535		27,535	25,675		25,675	U
138	0604258A	Target Systems Development	06	9,778	16,684		16,684	19,122		19,122	U
139	0604759A	Major T&E Investment	06	54,281	66,580		66,580	84,777		84,777	U
140	0605103A	Rand Arroyo Center	06	19,817	19,382		19,382	20,658		20,658	U
141	0605301A	Army Kwajalein Atoll	06	169,699	203,905		203,905	236,648		236,648	U
142	0605326A	Concepts Experimentation Program	06	18,757	19,430		19,430	25,596		25,596	U
143	0605502A	Small Business Innovative Research	06	172,658							U
144	0605601A	Army Test Ranges and Facilities	06	271,377	279,896		279,896	293,748		293,748	U
145	0605602A	Army Technical Test Instrumentation and Targets	06	43,961	51,550		51,550	52,404		52,404	U
146	0605604A	Survivability/Lethality Analysis	06	33,210	33,246		33,246	38,571		38,571	U
147	0605606A	Aircraft Certification	06	4,667	4,760		4,760	4,665		4,665	U
148	0605702A	Meteorological Support to RDT&E Activities	06	6,289	8,303		8,303	6,925		6,925	U
149	0605706A	Materiel Systems Analysis	06	20,578	20,403		20,403	21,677		21,677	U
150	0605709A	Exploitation of Foreign Items	06	8,418	10,396		10,396	12,415		12,415	U
151	0605712A	Support of Operational Testing	06	48,953	49,337		49,337	49,684		49,684	U
152	0605716A	Army Evaluation Center	06	54,468	52,694		52,694	55,905		55,905	U
153	0605718A	Army Modeling & Sim X-Cmd Collaboration & Integ	06	1,081	938		938	7,959		7,959	U
154	0605801A	Programwide Activities	06	63,687	60,319		60,319	51,822		51,822	U

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155	0605803A	Technical Information Activities	06	28,781	28,478		28,478	33,323		33,323	U
156	0605805A	Munitions Standardization, Effectiveness and Safety	06	62,168	64,604		64,604	40,545		40,545	U
157	0605857A	Environmental Quality Technology Mgmt Support	06	2,512	3,186		3,186	2,130		2,130	U
158	0605898A	Management HQ - R&D	06	48,951	48,955		48,955	49,885		49,885	U
159	0303260A	Defense Military Deception Initiative	06					2,000		2,000	U
160	0909999A	Financing for Cancelled Account Adjustments	06	233							U
	RDT&E	Management Support		1,166,015	1,070,581		1,070,581	1,136,134		1,136,134	
161	0603778A	MLRS Product Improvement Program	07	17,852	18,397		18,397	9,663		9,663	U
162	0603813A	TRACTOR PULL	07		9,461		9,461	3,960		3,960	U
163	0605024A	Anti-Tamper Technology Support	07					3,638		3,638	U
164	0607131A	Weapons and Munitions Product Improvement Programs	07		4,945		4,945	14,517		14,517	U
165	0607133A	TRACTOR SMOKE	07		7,569		7,569	4,479		4,479	U
166	0607134A	Long Range Precision Fires (LRPF)	07					39,275		39,275	U
167	0607135A	Apache Product Improvement Program	07	86,099	65,562		65,562	66,441		66,441	U
168	0607136A	Blackhawk Product Improvement Program	07	48,406	66,653		66,653	46,765		46,765	U
169	0607137A	Chinook Product Improvement Program	07	35,424	32,407		32,407	91,848		91,848	U
170	0607138A	Fixed Wing Product Improvement Program	07	819	1,151		1,151	796		796	U
171	0607139A	Improved Turbine Engine Program	07	49,328	51,164		51,164	126,105		126,105	U

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172	0607140A	Emerging Technologies from NIE	07	4,916	2,481		2,481	2,369		2,369	U
173	0607141A	Logistics Automation	07	3,513	1,673		1,673	4,563		4,563	U
174	0607665A	Family of Biometrics	07	1,332	13,237		13,237	12,098		12,098	U
175	0607865A	Patriot Product Improvement	07	57,962	89,816		89,816	49,482		49,482	U
176	0202429A	Aerostat Joint Project - COCOM Exercise	07	43,248	10,565		10,565	45,482		45,482	U
177	0203726A	Adv Field Artillery Tactical Data System	07	1,224							U
178	0203728A	Joint Automated Deep Operation Coordination System (JADOCS)	07	33,996	35,719		35,719	30,455		30,455	U
179	0203735A	Combat Vehicle Improvement Programs	07	297,423	354,667		354,667	316,857		316,857	U
180	0203740A	Maneuver Control System	07	43,453	15,408		15,408	4,031		4,031	U
181	0203744A	Aircraft Modifications/Product Improvement Programs	07	40				35,793		35,793	U
182	0203752A	Aircraft Engine Component Improvement Program	07	372	364		364	259		259	U
183	0203758A	Digitization	07	5,765	4,361		4,361	6,483		6,483	U
184	0203801A	Missile/Air Defense Product Improvement Program	07	4,917	3,154		3,154	5,122		5,122	U
185	0203802A	Other Missile Product Improvement Programs	07	40,468	35,951		35,951	7,491		7,491	U
186	0203808A	TRACTOR CARD	07	19,347	34,686		34,686	20,333		20,333	U
187	0205402A	Integrated Base Defense - Operational System Dev	07	4,196	10,750		10,750				U
188	0205410A	Materials Handling Equipment	07	802	402		402	124		124	U

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189	0205412A	Environmental Quality Technology - Operational System Dev	07	270							U
190	0205456A	Lower Tier Air and Missile Defense (AMD) System	07	78,720	64,159		64,159	69,417		69,417	U
191	0205778A	Guided Multiple-Launch Rocket System (GMLRS)	07	43,791	36,727		36,727	22,044		22,044	U
192	0208053A	Joint Tactical Ground System	07	10,209	20,515		20,515	12,649		12,649	U
194	0303028A	Security and Intelligence Activities	07	12,518	6,998		6,998	11,619		11,619	U
195	0303140A	Information Systems Security Program	07	13,627	31,154		31,154	38,280		38,280	U
196	0303141A	Global Combat Support System	07	5,225	21,574		21,574	27,223		27,223	U
197	0303142A	SATCOM Ground Environment (SPACE)	07	9,978	9,355		9,355	18,815		18,815	U
198	0303150A	WWMCCS/Global Command and Control System	07	2,493	7,034		7,034	4,718		4,718	U
201	0305179A	Integrated Broadcast Service (IBS)	07		750		750				U
202	0305204A	Tactical Unmanned Aerial Vehicles	07	20,290	13,225		13,225	8,218		8,218	U
203	0305206A	Airborne Reconnaissance Systems	07		22,870		22,870	11,799		11,799	U
204	0305208A	Distributed Common Ground/Surface Systems	07	20,155	25,592		25,592	32,284		32,284	U
205	0305219A	MQ-1C Gray Eagle UAS	07	46,472				13,470		13,470	U
206	0305232A	RQ-11 UAV	07					1,613		1,613	U
207	0305233A	RQ-7 UAV	07	16,389	11,797		11,797	4,597		4,597	U
208	0307665A	Biometrics Enabled Intelligence	07	1,973					7,104	7,104	U
209	0310349A	Win-T Increment 2 - Initial Networking	07	3,123	3,800		3,800	4,867		4,867	U

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210	0708045A	End Item Industrial Preparedness Activities	07	73,419	60,422		60,422	62,287		62,287	U
9999	9999999999	Classified Programs		14,302	4,536		4,536	4,625		4,625	U
		Operational Systems Development		1,173,856	1,211,051		1,211,051	1,296,954	7,104	1,304,058	
Total Research, Development, Test & Eval, Army				6,744,134	7,562,170	1,500	7,563,670	7,515,399	100,522	7,615,921	

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Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*

COST ($ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	45.563	68.314	31.533	-	31.533	31.849	32.666	33.286	34.367	-	-
H7B: *Advanced Materials Initiatives (CA)*	-	18.000	40.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-
H7G: *Nanomaterials Applied Research*	-	3.235	3.674	3.454	-	3.454	3.107	3.345	3.212	3.522	-	-
H84: *Materials*	-	24.328	24.640	28.079	-	28.079	28.742	29.321	30.074	30.845	-	-

A. Mission Description and Budget Item Justification

This Program Element (PE) evaluates materials for lighter weight and more survivable armor and for more lethal armaments. Project H7G researches and explores nanostructure materials properties and exploits the strength and durability of these materials to enable lighter weight, increased performance in Soldier weapons and protection applications. Project H84, researches a variety of materials and designs, fabricates and evaluates performance of components for lighter weight Soldier and vehicle armors, armaments, and electronics.

Work in this PE builds on the materials research transitioned from PE 0601102A (Defense Research Sciences), project H42 (Materials and Mechanics) and PE 0601104A (University and Industry Research Centers), project J12 (Institute for Soldier Nanotechnologies). This work complements and is fully coordinated with PE 0602601A (Combat Vehicle and Automotive Technology), PE 0602618A (Ballistics Technology), 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.

Work is performed by the Army Research Laboratory (ARL), Adelphi, MD and Aberdeen Proving Ground, MD, and the Massachusetts Institute of Technology.

Exhibit R-2, RDT&E Budget Item Justification: PB 2017 Army	**Date:** February 2016
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*

B. Program Change Summary ($ in Millions)	**FY 2015**	**FY 2016**	**FY 2017 Base**	**FY 2017 OCO**	**FY 2017 Total**
Previous President's Budget	46.000	28.314	30.295	-	30.295
Current President's Budget	45.563	68.314	31.533	-	31.533
Total Adjustments	-0.437	40.000	1.238	-	1.238
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	40.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.437	-			
• Adjustments to Budget Years	-	-	1.238	-	1.238

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2015**	**FY 2016**
Project: H7B: *Advanced Materials Initiatives (CA)*		
Congressional Add: *Program Increase*	18.000	35.000
Congressional Add: *High Performance Polymers Research*	-	5.000
Congressional Add Subtotals for Project: H7B	18.000	40.000
Congressional Add Totals for all Projects	18.000	40.000

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H7B: *Advanced Materials Initiatives (CA)*	-	18.000	40.000	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 provided for Advanced Materials Initiatives.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016
Congressional Add: Program Increase ***FY 2015 Accomplishments:*** Conducted research in the areas of Materials-by-Design; Energy Coupled to Matter; Strategic Materials; and Innovative Manufacturing Science. ***FY 2016 Plans:*** This is a Congressional Interest Item.	18.000	35.000
Congressional Add: High Performance Polymers Research ***FY 2016 Plans:*** This is a Congressional Interest Item	-	5.000
Congressional Adds Subtotals	18.000	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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H7G: *Nanomaterials Applied Research*	-	3.235	3.674	3.454	-	3.454	3.107	3.345	3.212	3.522	-	-

A. Mission Description and Budget Item Justification

This effort 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 2015	FY 2016	FY 2017
Title: Nanomaterials Applied Research	3.235	3.674	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 2015 Accomplishments: Developed new materials capable of selective energy absorption based on novel coating technologies using nano- and microparticles; synthesized unique molecules for use as additives in transparent eye protection materials that simultaneously solved processing issues and enhanced material performance; and demonstrated stability and performance of a daylight visible taggant system based on a quantum dot-enabled paint for covert tracking and combat identification applications.			
FY 2016 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Develop nano-structured protective materials and associated processing capabilities to enable novel light-weight materials solutions with enhanced impact performance; and develop 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:*** 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.			
Accomplishments/Planned Programs Subtotals	3.235	3.674	3.454

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: PB 2017 Army												Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H84: *Materials*	-	24.328	24.640	28.079	-	28.079	28.742	29.321	30.074	30.845	-	-

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 is conducted by the Army Research Laboratory (ARL) at Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Title: Structural Armor Materials	5.380	5.289	5.338
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 2015 Accomplishments: Developed improved delamination resistance and damage tolerance of thick composites using innovative, cost-effective manufacturing concepts; demonstrated ballistic performance of monolithic baseline magnesium (Mg) alloy and layered ceramic/ Mg alloy/ultra-high-molecular-weight polyethylene (UHMWPE) sandwich structure variants with weight reduction goal of 5-12% over current designs; developed validated physics-based models for fatigue of Mg alloy structures for lightweight vehicles that			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
eliminate traditional empirical modeling approaches; and validated novel algorithms to identify links between the microstructure of armor ceramics and ballistic performance, enabling both screening of as-processed tiles as well as development of next generation armor ceramics. ***FY 2016 Plans:*** Advance 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; mature development of damage tolerance concepts for thick composites through refinement of novel experimental and simulation strategies that enable material property and performance optimization through control of processing parameters; investigate 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.			
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 2015 Accomplishments:*** Developed a filament-level three-dimensional (3D) textile model for use in the development of soft body armor; developed and characterized new materials for extremity armor; and developed validated numerical modeling capability to analyze new materials for the range of personnel protection options that utilize the inherent multifunctional nature of composite materials to enhance survivability. ***FY 2016 Plans:*** Develop lab-scale processing approaches for boron-based ceramics using dopants and glassy films to achieve dramatic toughness improvements; investigate energy absorption improvements in helmet padding materials; and develop a validated multi-physics model predicting microstructure and residual stress in UHMWPE composites as a function of process history to enable improvements in material properties through process optimization. ***FY 2017 Plans:***	5.283	5.348	6.898

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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.			
Title: Lethality Materials Technology ***Description:*** This effort involves applied research to develop innovative materials solutions aimed at achieving leap-ahead increases in lethality and weapons effectiveness through dramatic improvements in weight and volume efficiency, lethal effects, and sustainability of military systems that can only be achieved through advances in materials technology. ***FY 2015 Accomplishments:*** Developed metal matrix composites to meet thermal requirements of gun barrels at reduced weight; utilized a combination of consolidation and diffusion processes to create nanostructured copper materials for coatings/liners that enable reduction in shape charge jet size while maintaining jet effect; and explored interfacial/bonding effects on the coupled and high loading rate failure modes in thermoplastic composites. ***FY 2016 Plans:*** Advance understanding of metal-based gun barrel materials by establishing wear properties and exploring active cooling technologies; determine properties and liner performance of nanostructured copper-based materials; and investigate 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.	4.395	4.483	4.492
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 2015 Accomplishments:*** Validated new embedded power and enhanced survivability capabilities in multifunctional composite materials using enhanced modeling and processing techniques; developed new additive manufacturing capabilities using 3D printing, cold spray, and/ or related techniques to explore methods for low-volume production and expand design space (e.g., bio-inspired protection	7.360	7.554	9.356

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
concepts); established electric field effects on select ceramics and metals to enable Electric Field Assisted Sintering (EFAS) of new multifunctional materials; and identified inelastic deformation mechanisms as a function of strain rate in silicon carbide armor ceramics through development of novel experimental techniques. ***FY 2016 Plans:*** Mature the additive manufacturing and processing of multi-component materials and develop a new simulation tool that links process science to the desired materials structure and properties; investigate the use of electromagnetic (EM) fields to control and optimize microstructure in metals and ceramics used in armor applications; assess the formation of ceramic materials through the use of low temperature solidification processing using locally sourced materials; and investigate and characterize 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 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.			
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/project H7G. ***FY 2015 Accomplishments:*** Developed thermally stable nanocrystalline cellulous particles and networks for incorporation into impact resistant transparent polymers used for personnel protection; established bulk mechanical properties of thermally stabilized nanocrystalline alloys to expand design space for structural and armor applications; and synthesized novel third generation chromophores and incorporated into thick polymer materials used in anti-laser sensor protection devices. ***FY 2016 Plans:*** Develop nanocellulose-based fibers with surface modifications for improved toughness and demonstrate improved impact strength in nanocellulose composites; investigate scaled-up fabrication of thermally stable iron-based nanomaterials with enhanced strength and ductility; and determine performance capabilities of nanostructure copper-based shaped charge liners. ***FY 2017 Plans:***	1.910	1.966	1.995

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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.			
Accomplishments/Planned Programs Subtotals	24.328	24.640	28.079

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: PB 2017 Army	Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	45.792	58.374	36.109	-	36.109	32.972	33.341	33.288	35.230	-	-
H16: *S3I Technology*	-	17.936	21.168	19.599	-	19.599	15.610	16.698	16.304	17.897	-	-
SA1: *Sensors and Electronic Initiatives (CA)*	-	12.750	20.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-
SA2: *Biotechnology Applied Research*	-	2.767	2.972	1.361	-	1.361	1.680	1.605	1.647	1.690	-	-
TS1: *Tactical Space Research*	-	4.593	5.808	6.702	-	6.702	7.026	7.072	7.213	7.357	-	-
TS2: *Robotics Technology*	-	7.746	8.426	8.447	-	8.447	8.656	7.966	8.124	8.286	-	-

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 US Army Space and Missile Defense Technical Center, Huntsville, AL.

Exhibit R-2, RDT&E Budget Item Justification: PB 2017 Army	**Date:** February 2016
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 2015**	**FY 2016**	**FY 2017 Base**	**FY 2017 OCO**	**FY 2017 Total**
Previous President's Budget	46.258	38.374	38.448	-	38.448
Current President's Budget	45.792	58.374	36.109	-	36.109
Total Adjustments	-0.466	20.000	-2.339	-	-2.339
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	20.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.466	-			
• Adjustments to Budget Years	-	-	-2.339	-	-2.339

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2015**	**FY 2016**
Project: SA1: *Sensors and Electronic Initiatives (CA)*		
Congressional Add: *Force Protection Radar Development*	5.000	-
Congressional Add: *Cyberspace security*	7.750	-
Congressional Add: *Program Increase*	-	12.500
Congressional Add: *Space and High Altitude Assets Survivability*	-	7.500
Congressional Add Subtotals for Project: SA1	12.750	20.000
Congressional Add Totals for all Projects	12.750	20.000

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H16: *S3I Technology*	-	17.936	21.168	19.599	-	19.599	15.610	16.698	16.304	17.897	-	-

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, decide 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 sensors designed to be employed in large numbers as networked sensors for force protection, hostile fire defeat, homeland defense, counter terrorism operations, and munitions; fusion of disparate sensors such as non-imaging acoustic, seismic, electric-field (E-field), magnetic field, radar; imaging infrared (IR), forward looking IR (FLIR), laser detection and ranging (LADAR), visible imagers; low cost acoustic, seismic, and magnetic sensors that can 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 as well as 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) allowing sensors to autonomously locate and identify targets; 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 (including Soldier's eyes) from battlefield laser threats; and advanced information processing methods to provide automatic information technologies that utilize widely dispersed sensor and legacy information sources.

This project supports Army science and technology efforts in the Command Control and Communications, Ground, and Soldier portfolios. The work in this project complements efforts funded in PE 0601104A (University and Industry Research Centers), Program Element (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 PE0601104A/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 and the Army Modernization Strategy.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Title: Non-Imaging Intelligence, Surveillance, and Reconnaissance (ISR) Sensing	5.539	5.435	4.675

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Description: This effort designs and characterizes technologies for multi-modal, low-cost networked sensors to enhance persistent sensing capabilities with increased probability of target detection and reduced false alarms. A key focus is on acoustic, seismic, magnetic field, electric field, and passive radio frequency (RF) with unique capabilities for Army and DoD applications that enable detection of underground facilities. ***FY 2015 Accomplishments:*** Exploited multimodal sensing, fusion, and sensor processing to detect and locate diverse threats using static and mobile sensors and networked systems; enhanced sensors and algorithms to provide persistent surveillance and actionable information; and exploited target features and mitigated environmental interference to enhance ISR capabilities. ***FY 2016 Plans:*** Develop advanced acoustic, magnetic- and electric-field sensors and arrays to detect and locate threats in complex environments; implement algorithms to mitigate effects of acoustic propagation channel and signature modifications to optimize transient classification of mortar, rocket, gunfire and explosive events; apply electric and magnetic field phasor processing to detect and classify equipment and power events; and develop 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.			
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, such as tunnels, caves, sewers, and buildings, (2) interoperability and networking of disparate sensors and information sources, (3) distributed information for decision-making, and (4) approaches for fusing results of processed outputs of multi-modal sensors such as visible, IR, and hyperspectral imagers, and acoustic, magnetic, and electric field sensors. This effort complements efforts funded in PE 0601104A/H50 (Network Sciences CTA) and PE0601104A/J22 (Network Science and Technology Research Center CTA). ***FY 2015 Accomplishments:***	4.843	5.474	5.506

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Implemented anomaly detection algorithms by fusing the output of social network with disparate multimodal sensors to determine patterns of behavior; enhanced acoustic, magnetic and electric field sensors and algorithms to detect, classify, and localize hostile transient threat events such as mortars, rockets, gunfire, and moving ground/air vehicles, to include UAS; and mitigated background noise resulting from mobile sensor systems in complex environments. ***FY 2016 Plans:*** Expand tools to improve search capabilities of relevant social media data to fuse with sensor data; expand interoperability for sensor plug-and-play capabilities and quick integration across unmanned sensors; design algorithms that will exploit electric and magnetic field sensor fusion for electrical power event monitoring; and design detection, tracking and cueing methodologies for counter-unmanned aerial 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.			
Title: Ultra Wideband (UWB) Radar ***Description:*** This effort examines the technical underpinnings of UWB radar for several key Army concealed target detection requirements, including landmine and improvised explosive device (IED) detection, sensing through-the-wall, and obstacle detection. This research uses a combination of advanced computational electromagnetic algorithms, radar measurements, and advanced signal processing techniques to define the performance boundaries of state-of-the-art airborne and ground-based UWB radar for concealed target detection. ***FY 2015 Accomplishments:*** Assessed performance of UWB radar with complementary sensor techniques and technologies and compared to the current target detection capabilities and performance metrics; and investigated computational electromagnetic models to address new target deployments. ***FY 2016 Plans:*** Investigate 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; incorporate stereo visible cameras to provide three-dimensional	2.913	2.892	1.794

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
reconstruction of the environment that can be fused with radar image formation algorithms; and investigate and validate 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 three-dimensional (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.			
Title: Networked Compact Radar, Wide Bandgap Optoelectronics, and Laser Protection Technologies	3.083	3.854	3.757
Description: This effort investigates RF networking technology in support of integrated RF systems for use on ground, air, and Soldier platforms to support radio, radar, and control functions to allow communications, combat identification, and target acquisition/tracking. Research also focuses on semiconductor-based ultraviolet UV optoelectronics for communications, water/air/surface purification, and detection and identification of biological threats, and novel materials and high-speed switching technology for sensor and eye protection. ***FY 2015 Accomplishments:*** Grew and characterized wide bandgap semiconductor materials and developed device designs to extend the spectral range of UV lasers, Light Emitting Diodes (LEDs), and detectors to wavelengths from 200 to 365 nanometers to enable water/air/surface purification and the detection and identification of biological threats; investigated different materials and characterized solutions for eye and sensor protection against ultra-short pulses and near-IR high power threats. ***FY 2016 Plans:*** Study and characterize 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 investigate 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			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
power greater than 20 mW in the wavelength range of 200-290 nm, and photodetectors with single-photon detection capability across the UV spectral range for Army applications including water sterilization, non-line-of-sight communications, and chemical-biological detection.			
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 2015 Accomplishments:*** Investigated current and emerging technologies, across a broad RF spectrum, which may limit the performance of current air defense radar systems; modified existing physics-based electromagnetic modeling techniques to assess performance and identify critical areas of research; and examined performance in contested environments and research techniques to mitigate performance limitations. ***FY 2016 Plans:*** Model air targets to investigate multiband architectures, alternative spectrum configurations, and broadband apertures; investigate spectrum sensing algorithms specific to air defense radar bands (e.g., L-band thru X-band and beyond); and investigate novel tracking algorithms for rockets, artillery, and mortar targets for next generation air defense radar. ***FY 2017 Plans:*** 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.	1.558	3.513	3.867
Accomplishments/Planned Programs Subtotals	17.936	21.168	19.599

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** H16 / *S3I Technology*

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
SA1: *Sensors and Electronic Initiatives (CA)*	-	12.750	20.000	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 provided for Sensors and Electronic Initiatives.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016
Congressional Add: Force Protection Radar Development ***FY 2015 Accomplishments:*** Congressional interest item for Force Protection Radar Development	5.000	-
Congressional Add: Cyberspace security ***FY 2015 Accomplishments:*** Congressional interest funding for cyberspace security research	7.750	-
Congressional Add: Program Increase ***FY 2016 Plans:*** This is a Congressional Interest Item	-	12.500
Congressional Add: Space and High Altitude Assets Survivability ***FY 2016 Plans:*** This is a Congressional Interest Item	-	7.500
Congressional Adds Subtotals	12.750	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: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
SA2: *Biotechnology Applied Research*	-	2.767	2.972	1.361	-	1.361	1.680	1.605	1.647	1.690	-	-

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), 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 and the Army Modernization Strategy.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Title: Biotechnology Applied Research	2.767	2.972	1.361
Description: This effort exploits breakthroughs in biotechnology basic research accomplished at the ICB to enable new capabilities in sensors, electronics, photonics, and network science.			
FY 2015 Accomplishments: Investigated performance limits of hybrid biofuel cells for powering unattended ground sensors or other remote, stand-alone monitoring systems; studied interface technologies using bio-assembled materials for small-scale batteries on unmanned aerial vehicles (UAVs); and developed and studied rapid bio-based screening, selection, and production processes for recognition and targeting of emerging threats to the Soldier.			
FY 2016 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Test hybrid biofuel cells; develop and test assays with advanced protein capture agents to validate capability to rapidly respond to emerging threats; evaluate bio-inspired algorithms for control applications including decision support tools to unburden UAV operators; and conduct 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 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.			
Accomplishments/Planned Programs Subtotals	2.767	2.972	1.361

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
TS1: *Tactical Space Research*	-	4.593	5.808	6.702	-	6.702	7.026	7.072	7.213	7.357	-	-

A. Mission Description and Budget Item Justification

This project researches and evaluates 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, 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 Modernization Strategy.

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 2015	FY 2016	FY 2017
Title: Tactical Space Research	3.621	4.787	5.664
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 2015 Accomplishments: Developed payload deployer subsystem for affordable launch vehicle; designed and developed advanced attitude determination and control and propulsion subsystems for nanosatellites to change orbits in flight.			
FY 2016 Plans: 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:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 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.			
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 2015 Accomplishments:*** Validated performance of Hardware In The Loop nanosatellite attitude control, to include attitude control software, device integration, and in-flight simulation of commanded motion. ***FY 2016 Plans:*** Develop 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.	0.972	1.021	1.038
Accomplishments/Planned Programs Subtotals	4.593	5.808	6.702

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
TS2: *Robotics Technology*	-	7.746	8.426	8.447	-	8.447	8.656	7.966	8.124	8.286	-	-

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 2015	FY 2016	FY 2017
Title: Robotics CTA	3.487	3.790	3.811
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: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
FY 2015 Accomplishments: Incorporated perception and intelligence algorithms into effective teaming of humans and robots as part of a mixed team to successfully conduct missions; conducted technology assessments of components and integrated systems to determine performance and technology maturity levels; and implemented perception and reasoning skills with technology test beds employing unique mobility modes (e.g., legs, and manipulation skills) to assess technology performance levels. ***FY 2016 Plans:*** 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.			
Title: Perception and Intelligent Control ***Description:*** Advance perception and intelligent control technologies required to achieve autonomous tactical behaviors 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 2015 Accomplishments:*** Developed the perceptual and reasoning capabilities necessary to enable an unmanned system to deduce the intent of actions/ activity; and explored and implemented on test bed platforms the mechanisms and control algorithms that will enable autonomous unmanned systems to dexterously manipulate objects and maneuver through complex terrain, with an emphasis on increased efficiency. ***FY 2016 Plans:*** Continue 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	4.259	4.636	4.636

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
as communication with human teammates; and conduct experiments focused upon establishing technology maturity and performance gaps. ***FY 2017 Plans:*** 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.			
Accomplishments/Planned Programs Subtotals	7.746	8.426	8.447

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: PB 2017 Army	Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	16.358	6.879	6.995	-	6.995	7.120	7.164	7.306	7.453	-	-
622: *D622*	-	2.218	2.396	2.275	-	2.275	2.315	2.329	2.375	2.423	-	-
B72: *AB72*	-	14.140	4.483	4.720	-	4.720	4.805	4.835	4.931	5.030	-	-

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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Previous President's Budget	16.358	6.879	6.995	-	6.995
Current President's Budget	16.358	6.879	6.995	-	6.995
Total Adjustments	0.000	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army												Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
622: *D622*	-	2.218	2.396	2.275	-	2.275	2.315	2.329	2.375	2.423	-	-

A. Mission Description and Budget Item Justification

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

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
B72: *AB72*	-	14.140	4.483	4.720	-	4.720	4.805	4.835	4.931	5.030	-	-

A. Mission Description and Budget Item Justification

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2017 Army	Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	62.046	56.884	65.914	-	65.914	65.902	68.583	69.932	63.601	-	-
47A: *AERON & ACFT Wpns Tech*	-	54.212	48.377	56.159	-	56.159	55.468	57.886	59.024	52.400	-	-
47B: *Veh Prop & Struct Tech*	-	7.834	8.507	9.755	-	9.755	10.434	10.697	10.908	11.201	-	-

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. This PE supports the National Rotorcraft Technology Center (NRTC), a partnership of government, industry, and academia.

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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Previous President's Budget	63.414	56.884	65.914	-	65.914
Current President's Budget	62.046	56.884	65.914	-	65.914
Total Adjustments	-1.368	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.368	-			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army												Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
47A: *AERON & ACFT Wpns Tech*	-	54.212	48.377	56.159	-	56.159	55.468	57.886	59.024	52.400	-	-

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 supports the National Rotorcraft Technology Center (NRTC), a partnership of government, industry, and academia. 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 2015	FY 2016	FY 2017
Title: National Rotorcraft Technology Center (NRTC)	4.947	4.704	4.686
Description: NRTC focuses government, 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 2015 Accomplishments: Developed industry accepted criteria and repair methods for lightly damaged gear tooth repair, enhanced understanding of surface finish effect on gear noise; improved fatigue life and stress corrosion cracking mitigation for magnesium castings; and explored laser scanning technology to improve the fidelity and speed of housings and dynamic components inspection techniques.			
FY 2016 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Conduct 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:*** 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 ***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 2015 Accomplishments:*** Conducted studies on the highly complex, non-linear, downwash/outwash flow field beneath a sub-scale rotor in hover to refine current physical understanding and non-intrusive diagnostics techniques; improved the accuracy and efficiency of computational software that models full-vehicle rotorcraft aerodynamics on high-performance parallel computers; analyzed performance, aerodynamics and structural dynamics for advanced rotorcraft configurations; updated Aeronautical Design Standards (ADS-33) to integrate lessons learned from the Degraded Visual Environment-Mitigation (DVE-M) Program and slung load handling qualities measurements into new requirements; developed and simulated methods of controlling dual lift configurations; and analyzed and simulated flight control concepts for advanced rotorcraft configurations. ***FY 2016 Plans:*** Develop and assess high-fidelity computational models of complete rotorcraft for the aerodynamics and dynamics in both straight and level and maneuver flight. Complete 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 enable refinement of modeling and simulation tools using measured downwash/outwash data. Develop innovative diagnostic techniques to measure and improve understanding of interactional aerodynamic phenomena. Integrate rotors and vehicle management system technologies to reduce rotor loads, reduce hub and airframe drag and improve vehicle performance. Conduct flight experiments of dual-lift flight control. Integrate flight control and handling qualities analysis into Army preliminary design tools NASA Design and Analysis of Rotorcraft (NDARC) for advanced rotorcraft configurations. Conduct piloted handling	8.586	9.431	10.795

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 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.			
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 2015 Accomplishments:*** Completed performance and material analyses of lightweight composite transparent armor system and validated analyses through laboratory test; completed chemical analysis of JP-8 and alternative fuel blends; completed fabrication of test specimens for crashworthy ballistic fuel containment systems, and validated analyses through laboratory tests; leveraged flight test in part and full mission simulators to validate performance models of active crash protection system algorithms; completed the development of electro-optical (EO) /infrared (IR) materials, and conducted sub-scale testing of developed EO/IR materials for signature control and environmental durability; investigated preliminary near real-time survivability route planning algorithms; investigated Adaptive IR engine suppressor capability designed to optimize IR signature reduction and aircraft lift and range performance ***FY 2016 Plans:*** Develop and evaluate composite armor integrated into primary load bearing structure systems to improve conventional threat protection while reducing overall system weight. Evaluate passive and active energy attenuating devices integrated into primary structure to improve crashworthiness while reducing overall system weight. Conduct ballistic and crash experiments on lightweight	9.108	4.494	6.095

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
composite armor components and energy attenuating devices to verify performance. Develop 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 IR signature and engine performance of the integrated system.			
Title: Engine and Drives Technologies ***Description:*** Design and evaluate advanced turboshaft engine component technologies to support goals of reduced fuel consumption, engine size, weight, and cost, as well as improved reliability and maintainability. Design and evaluate advanced drive system component technologies to support multi-speed transmissions, lighter weight gearboxes, and reduced costs, while improving reliability and maintainability ***FY 2015 Accomplishments:*** Completed investigation of advanced variable speed power turbine for improved performance and operational capability; completed alternate engine concepts design and analysis effort; performed conceptual design analysis of advanced integrated engine/flight controls with integrated health management for reduced weight/cost and improved reliability/fault detection; designed/ fabricated clutchless concepts for multi-speed gearbox component testing; developed integral shaft/bearing races to reduce weight in large gearboxes and investigated new high-strength, corrosion resistant materials for drive system applications. ***FY 2016 Plans:*** Perform the conceptual design and determine 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; develop design of a smart, adaptable, and efficient sand filtration system for improved engine performance and durability; and design drive train technologies with multi-speed (ability to vary shaft speed between 50 and 100%) to support development of next generation rotorcraft transmission and Future Vertical Lift 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	4.974	3.600	6.608

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 ***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 system reliability. Work is coordinated with Aviation Component Failure Modeling efforts in PE 0602211, Project 47B at Army Research Laboratory (ARL). ***FY 2015 Accomplishments:*** Continued enhancement and refinement of vehicle costing methodologies, analytical efficiencies and accuracy; applied modeling and simulation tools to design and perform analysis of the Family of Systems (FoS) for FVL to support "Zero Maintenance" helicopter concepts; investigated and developed physics of failure modeling to improve reliability of system components, and to enable damage tolerant component design; investigated methods to monitor component loads and integrate with aircraft controls to stay within component failure limits; and investigated modeling and simulation methods to reduce the time required to design and develop new aircraft ***FY 2016 Plans:*** Continue 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. Apply modeling and simulation tools to support design of FVL/novel concepts and analysis of their operational feasibility. Enhance probabilistic structural integrity and useful life analytical techniques through improved damage initiation and propagation models; develop and perform 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	7.334	7.331	6.322
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 aerial system (UAS) components to support goal of improved	6.351	6.603	6.909

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
small UAS performance. When applicable, technologies in this area are leveraged to support mitigation of degraded visual environments (DVE). ***FY 2015 Accomplishments:*** Developed optimal human-machine visual, aural, and tactile interfaces for manned-unmanned teaming (MUM-T) that supports efficient mission execution and safe flight operations with high situational awareness for pilots and unmanned aerial system operators. Built upon previous sensor and symbology efforts, design and develop methods to optimally blend forward-looking synthetic and enhanced vision sensor information with cueing symbology that aids the helicopter pilot or operator in control of the helicopter in DVE; and investigated advanced technologies to increase task and mission effectiveness of unmanned aerial systems when partnered with ground and airborne soldiers, including autonomous behaviors, perception, autonomy architectures, and human aiding. ***FY 2016 Plans:*** Investigate 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. Optimally blend 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. Include close proximity flight in a simulation environment and develop technology for a simulation experiment. Develop 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.			
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 2015 Accomplishments:***	1.579	1.604	1.625

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Investigated integrated targeting/intelligence, surveillance, and reconnaissance (ISR) sensors and alternative targeting sensors; assessed emerging lethal and non-lethal deterrent weapons capabilities for development and aircraft integration; and prepared the lightweight remote control system for follow on testing. ***FY 2016 Plans:*** Develop 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. Conduct lab based sensor networking and experimentation to verify the enhanced sensor integration and fusion capabilities. Conduct 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. Continue to support Aviation and Missile Research, Development, and Engineering Center (AMRDEC) Missile PE 0603313A, and Communications and Electronics Research, Development, and Engineering Center (CERDEC) Night Vision and Electronic Sensors Directorate (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.			
Title: Maintainability & Sustainability Technologies ***Description:*** Develop prognostic and system health assessment technologies to enable an enhanced Condition Based Maintenance 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 2015 Accomplishments:*** Developed embedded multi-functional sensors with built-in processing and communications; developed health assessment systems to support adaptive controls; developed technologies for component self-assessment, usage tracking and embedded history; and investigated technologies to provide health monitoring to support and optimize design efficiencies. ***FY 2016 Plans:*** Investigate use of wireless communication technologies to reduce wiring weight associated with prognostics and diagnostics; Integrate health assessment technologies into Joint Common Architecture (JCA)/avionics/cockpit; will develop fly-by-wire (FBW) with CBM monitoring capability; Develop miniaturized wireless sensors with on-component processing, history and parts tracking; Develop improved fleet management capability with autonomous logistics for parts/production control; Investigate technologies for in-flight data transmission to ground. ***FY 2017 Plans:***	3.504	2.104	3.619

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 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.			
Title: Survivability For Degraded Visual Environment (DVE) Operations	7.829	8.506	9.500
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 2015 Accomplishments: Investigated multi-resolution fusion sensor package comprised of a 94 GHz millimeter wave radar, a laser radar (LADAR) and an infrared (IR) camera; investigated alternative fusion techniques with a different form of LADAR and an IR camera; conducted experiments focused on optimizing the forward flight modernized control laws (MCLAWS) of the Blackhawk UH-60 aircraft in preparation for a planned Fiscal Year (FY) 2016 DVE-M flight test; and explored the value of additional cueing techniques such as tactile and aural technologies in the AMRDEC simulation facility at Redstone Arsenal, Alabama. This work fed a 6.3 DVE-M tech demo effort beginning in FY16.			
FY 2016 Plans: Execute 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. Continue software algorithm and materiel component design and development for execution of sensor fusion involving LADAR, RADAR & IR systems for two separate DVE Mitigation Program lines of effort. Execute 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:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 FY20 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.			
Accomplishments/Planned Programs Subtotals	54.212	48.377	56.159

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
47B: *Veh Prop & Struct Tech*	-	7.834	8.507	9.755	-	9.755	10.434	10.697	10.908	11.201	-	-

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 2015	FY 2016	FY 2017
Title: Rotor and Structure Technology	2.342	2.547	2.589
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 2015 Accomplishments: Investigated novel approaches to improve rotorcraft vehicle maintainability; investigated the feasibility of aeroelastic/ aeromechanical stability enhancement of composite rotor blades through novel material concepts; developed wind-tunnel models to study advanced active-control helicopter rotor systems; provided advanced structural dynamics models of rotorcraft fuselage structures; and explored and evaluated plasma discharge based active flow control techniques for rotor dynamic stall alleviation and diffuser augmented rotor systems.			
FY 2016 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 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.			
Title: Engine and Drive Train Technology (previously titled Propulsion and Drive Train Technology) ***Description:*** Investigate high temperature materials, advanced models for flow physics and improved methods for predicting propulsion system mechanical behavior to increase fuel efficiency and reduce propulsion system weight. ***FY 2015 Accomplishments:*** Evaluated the benefits of advanced technologies such as improved fuel spray, multi-fuel capability, etc., for aviation system engine performance and durability at sea level and simulated altitude conditions; and demonstrated drive train technologies with 50% increase in time-to-scuffing-failure after lubricant supply is terminated in a simulated gear environment and identified promising technologies to achieve +50% oil-out time in support of next generation rotorcraft transmission objectives. ***FY 2016 Plans:*** Investigate coupled physics-based probabilistic design of ultra-lightweight hybrid gear; validate component modeling on extended design space for variable-speed turbine; and investigate 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.	3.040	3.198	2.678
Title: Micro/Small Scale Unmanned Aerial Systems	1.475	1.762	3.488

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Description: Investigate platform, aerodynamic, actuation, transmission, and control technologies for handheld autonomous UAS. Handheld autonomous UAS willprovide 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 assetsthat help to minimize the supporting infrastructure needed for deployment. ***FY 2015 Accomplishments:*** Implemented open loop control strategies employing active aerodynamic or elastic actuation to aircraft form factors for achieving gust and other disturbance rejection capability; incorporated bio-inspired sensors for enhanced state and disturbance awareness; evaluated technologies addressing the communication and processing needs of size, weight, and power constrained platforms; established an aeromechanics analysis tool integrating fluid dynamics and structural dynamics solvers; investigated wing flexibility/morphing for performance enhancements; and performed quantitative technology and tradeoff analyses of independent flapping wing control for maneuvering micro aerial vehicles (MAVs). This effort is coordinated with PE 0601104A/Project H54 (Micro Autonomous Systems Technology Collaborative Technology Alliance). ***FY 2016 Plans:*** Investigate a span-adaptive wing which yields relatively consistent performance across its span range while responding to slowly varying conditions in a wind tunnel; and validate 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.			
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 U.S. Army Aviation and Missile Research, Development and Engineering Center. ***FY 2015 Accomplishments:*** Developed and improved failure models to characterize and categorize specific material damage precursors relevant to aviation components; developed a probabilistic framework for predicting remaining useful life of vehicle platforms; investigated the	0.977	1.000	1.000

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
integration of advanced aviation component health monitoring techniques into health-usage monitoring systems (HUMS); and developed self-sensing structural material technologies that incorporate damage precursor detection philosophy. ***FY 2016 Plans:*** Develop 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” 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.			
Accomplishments/Planned Programs Subtotals	7.834	8.507	9.755

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: PB 2017 Army	Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	19.333	19.243	25.466	-	25.466	25.041	24.822	24.737	25.172	-	-
906: *Tactical Electronic Warfare Applied Research*	-	19.333	19.243	25.466	-	25.466	25.041	24.822	24.737	25.172	-	-

A. Mission Description and Budget Item Justification

This Program Element (PE) designs and validates electronic warfare (EW) components 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) 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. Specifically, 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 is complementary of 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 fully coordinated with PE 0603008A (Command, Control, Communications Advanced Technology), 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: PB 2017 Army	Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Previous President's Budget	18.500	19.243	20.466	-	20.466
Current President's Budget	19.333	19.243	25.466	-	25.466
Total Adjustments	0.833	0.000	5.000	-	5.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	1.000	-			
• SBIR/STTR Transfer	-0.167	-			
• Adjustments to Budget Years	-	-	5.000	-	5.000

Change Summary Explanation

Fiscal Year (FY) 2017 increase to expand research on offensive cyber and signals intelligence.

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
906: *Tactical Electronic Warfare Applied Research*	-	19.333	19.243	25.466	-	25.466	25.041	24.822	24.737	25.172	-	-

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.

This project supports Army science and technology efforts in the Command, Control, Communications and Intelligence, Ground Maneuver, Soldier/Squad and Air 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, Development, and Engineering Command, Communications-Electronics Research, Development, and Engineering Center (CERDEC), Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Title: Multi-Intelligence Data Fusion and Targeting	2.695	2.720	2.720
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 2015 Accomplishments:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Investigated methods to fuse biometric enabled intelligence analysis results with other forms of intelligence data to improve the overall quality of data products; designed methods and analysis software tools and algorithms to extract biometric and contextual data from streaming video sources; began designing and coding of software tools to assign quality scores to data gathered from non-dedicated biometric sources. ***FY 2016 Plans:*** Design biometric/video architecture capable of pulling non-traditional biometric data from disparate video sources and integrate biometric extraction and analysis algorithms into this architecture; experiment with and evaluate software tools for biometric 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.			
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. Work being accomplished under PE 0603270A/project K15 complements this effort. ***FY 2015 Accomplishments:*** Investigated the impacts on cyber/EW techniques of converging disparate RF devices into a common hardware and software platform; developed coordinated cyber/EW techniques to exploit tactically relevant targets; analyzed and developed performance predictions for various techniques being employed on different cyber and EW platforms. ***FY 2016 Plans:*** Investigate advanced techniques against next-generation signals of interest (SOIs); research an architecture for resilient operations across cyber, EW and signal intelligence (SIGINT) assets; investigate 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	6.848	5.843	7.857

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 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.			
Title: Multispectral Threat Warning ***Description:*** This effort investigates and evaluates software and sensor/countermeasure components to increase probability of detection of small arms and probability of detection and defeat of 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 2015 Accomplishments:*** Evaluated effectiveness of current countermeasures techniques against additional classes of emerging multi-spectral threats required by Common IR Countermeasures program of record; expanded laboratory and M&S environment to accommodate assessment of advanced threat countermeasures; initiated design, fabrication and encoding of techniques and technologies that provide countermeasures against multi-spectral IR and RF threats; investigated multi-band signature management exploitation and design correlation techniques for improved threat detection, identification and countermeasures. ***FY 2016 Plans:*** Investigate and develop hardware and software simulation environment to assess countermeasures with appropriate level of simulation fidelity based on threat specifications and studies; explore ways to exploit a second class of emerging threats and assess baseline countermeasure techniques against this second class of emerging threat; develop holistic countermeasure approaches to protect aviation platforms and investigate application of additional technologies to support threat detection as well as optimize 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	5.283	5.309	5.367
Title: Multi-Function Intelligence, Surveillance and Reconnaissance (ISR) Technologies ***Description:*** This effort investigates and codes software algorithms and techniques to intelligently integrate tactical ISR sensors, improve their individual performance and increase the effectiveness of battlespace awareness/intelligence data in an area of	3.318	4.171	8.522

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 complements this effort. ***FY 2015 Accomplishments:*** Studied the feasibility of combining a series of synthetic aperture radar (SAR) images to develop a motion video-like data product for more reliable entity resolution and real time tracking; established metrics for measuring and judging the quality of SAR motion video products; investigated techniques to identify and mitigate the impact of intentional red force interference sources on friendly ISR assets. ***FY 2016 Plans:*** Investigate and define 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; analyze and determine 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.			
Title: Electronic Warfare Architectures and Countermeasures ***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 2015 Accomplishments:*** Analyzed existing blue force ground EW systems to determine potential deficiencies or weaknesses in the system design and implementation that could be exploited by red forces; investigated emerging red force EW system architectures to identify design characteristics that can be exploited by blue force EW systems to limit their effectiveness ***FY 2016 Plans:*** Analyze modular open RF architecture interfaces to determine vulnerabilities that emerged as component interactions are standardized; continue the evaluation of emerging scheduling algorithms for use within the architecture to coordinate various mission functions (SIGINT, EW, Communications); design software for automated classification, detection, identification and	1.189	1.200	1.000

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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.			
Accomplishments/Planned Programs Subtotals	19.333	19.243	25.466

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: PB 2017 Army	Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	61.144	53.553	44.313	-	44.313	45.326	46.744	47.543	48.494	-	-
214: *Missile Technology*	-	45.144	45.053	44.313	-	44.313	45.326	46.744	47.543	48.494	-	-
G05: *MISSILE TECHNOLOGY INITIATIVES (CA)*	-	16.000	8.500	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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Previous President's Budget	62.180	45.053	44.313	-	44.313
Current President's Budget	61.144	53.553	44.313	-	44.313
Total Adjustments	-1.036	8.500	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	8.500			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.036	-			

Exhibit R-2, RDT&E Budget Item Justification: PB 2017 Army	Date: February 2016
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2015	FY 2016
Project: G05: *MISSILE TECHNOLOGY INITIATIVES (CA)*		
Congressional Add: *Program Increase*	16.000	8.500
Congressional Add Subtotals for Project: G05	16.000	8.500
Congressional Add Totals for all Projects	16.000	8.500

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
214: *Missile Technology*	-	45.144	45.053	44.313	-	44.313	45.326	46.744	47.543	48.494	-	-

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 Program element (PE) 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 2015	FY 2016	FY 2017
Title: Smaller, Lighter, Cheaper Tactical Missile Technologies	12.704	-	-
Description: This effort designs and evaluates innovative smaller, lighter, and cheaper component technologies as well as system concepts to reduce ground tactical precision missile cost per kill and/or logistics burden to meet urban and emerging threats. These technologies transition to PE 0603313A for maturation.			
FY 2015 Accomplishments: Completed design, fabrication, and test of advanced composite housing for Javelin Light Weight Command Launch Unit (LW CLU); fabricated and tested a small, lightweight, low power inertial navigation sensor developed for robust man-portable close-combat targeting performance, and completed design of an increased accuracy modular inertial navigation sensor with reduced size, weight, and power (SWaP) and on-the-move capabilities (both targeting and navigation); fabricated and tested reduced SWaP, increased range acquisition sensor for Javelin LW CLU; integrated components into CLU housing and evaluated; continued trade studies of the next-generation close combat, precision weapon systems for performance against increased target sets; developed and tested advanced guidance and tracking technologies for improved target acquisition at increased range;			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
investigated, developed and evaluated applications for novel methods and tools to provide increased weapon precision and reduce target location error.			
Title: Missile Seeker Technology ***Description:*** This effort focuses on the design, fabrication and evaluation of missile seekers, sensors, and software. The goal is to increase affordability and performance of missile seekers through improvement of algorithms, imaging, and thermal management. ***FY 2015 Accomplishments:*** Continued technology maturation of novel micro-cooler technologies for advanced infrared tactical seekers to increase range performance and improve size, weight, and power; tested ultra small and low cost semi-active laser seeker technology for improved flexibility and use on a variety of missile platforms including aviation and long range fires missiles; integrated programmable laser proximity sensor components and filter algorithms that will maintain operation in the presence of obscurants; completed the development of advanced technologies for affordable phased array sensors that enable all-weather operation of missile seekers and fire control. ***FY 2016 Plans:*** Fabricate, integrate, and test novel micro-cooler technologies, improving size, weight, power and reliability of advanced infrared tactical seekers; design and fabricate advanced ultra-small seeker components for integration into reduced-weight missiles, including aviation and long range fires missiles; develop and refine sensor and software algorithms to improve the detection and tracking of airborne threats. ***FY 2017 Plans:*** Will mature and assess capability of a compact, low cost radially omni-directional laser target detection device for the counter unmanned aerial systems (UAS) mission; will mature and evaluate a laser-based, shared-aperture system capable of detecting and tracking sensor payloads of threat UAS; will 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 for improved and uniform performance; and will 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 will be form factored for use on small guided munitions with modular open systems architectures.	7.443	3.757	4.659
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	6.641	6.437	7.630

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 2015 Accomplishments:*** Developed, integrated and evaluated navigation technologies and algorithms capable of providing accuracy in GPS available and GPS denied/challenged environments to include: vision-aided, enhanced navigation-grade gyros, accelerometers, and unique inertial systems and GPS Anti-Jam /Anti-Spoofing systems; continued to develop, integrate and demonstrate state-of-the-art integration techniques for Commercial Off the Shelf (COTS) inertial sensors representing low cost, high accuracy navigation systems for extremely dynamic missile environments; developed, integrated, and demonstrated inertial technologies aimed at reducing size, weight, power and cost, while increasing accuracy. ***FY 2016 Plans:*** Develop 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; continue 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; design 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:*** Will 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; will design small, precision inertial sensors/accelerometers for fast, accurate north finding capability required to support target location systems/ missile initialization; will 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 battery storage shelf life through integration of donor power storage technologies and subsystems to increase shelf life for small maneuvering missile applications; will 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; will 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.			
Title: Missile Fire Control Systems, Sustainment, Simulations, and Launchers	2.985	5.473	7.355

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 2015 Accomplishments:*** Developed phased array radar technology for fire control systems and supporting thermal management, to include small, low-cost, lightweight designs using commercially-available components and commercial processes with integrated thermal structures to enable effective power levels; further developed target identification algorithms for integration with radar systems to increase targeting fidelity. Continued development of missile health monitoring unit to improve user interface to reduce sustainment costs and increases readiness; optimized health monitoring units for reduced cost, power, and volume and operation in dynamic vibration environments using micro-electromechanical systems (MEMS). ***FY 2016 Plans:*** Design and fabricate 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; design and fabricate radar testbed critical components such as transmit/receive modules; further mature target identification and classification algorithms focusing on integrating infrared imagery and development of ground target feature extraction increasing targeting fidelity and situational awareness; analyze novel copper wire bond material properties and design methodology to define qualification and acceptance for missile electronics reliability; develop initial radio frequency (RF) predictive methodologies to create valid and reliable threat UAS RF models facilitating advanced simulations for air defense activities. ***FY 2017 Plans:*** Will 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; will 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; will investigate and design an open/modular architecture for future missile health monitoring units (HMUs) that address shortfalls/limitations in existing fielded capability and accommodate lower cost/quicker expansion of missile HMU capability; will continue to mature UAS modeling validation processes with establishment of RF predictive methodologies; will 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			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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.			
Title: Missile Propulsion, Structures, Lethality, and Aerodynamic Technology	5.653	6.069	5.658
Description: This effort designs, fabricates, evaluates and tests missile enabling technologies including: advanced missile propulsion with reduced launch signatures; increased lethality and range of lethality effects; improved structural integrity of light weight missile cases; and increased understanding of missile aerodynamics for improved performance. Missile Propulsion, Structures and Lethality efforts are in coordination with PE 0602618A, Project H80 and PE 0602624A, Project H28.			
FY 2015 Accomplishments: Tested novel propulsion structures to increase missile range and decrease time of flight of minimum signature propulsion systems; developed vibration-induced material degradation models of propulsion systems for stockpile reliability models to extend missile life; developed new methodologies that accurately characterize base flow predictions for complex aft bodies to improve aerodynamic predictability; continued modeling and analysis to determine the vulnerability of UASs to fragment impact and blast effects to enable the design of counter UAS missiles; continued to evaluate high performance compact warhead designs in collaboration with the Armaments Research, Development, and Engineering Center.			
FY 2016 Plans: Continue test and refinement of novel propulsion systems to increase missile range and reduce time of flight for extended range propulsion systems; design and conduct performance testing of structurally optimized missile components developed using additive manufacturing techniques for reduced weight and improved strength missile components; fabricate and perform system integration tests of lightweight warhead case technologies to provide reinforced structure defeat capability; investigate, scale up and test emerging disruptive energetic material from the Army Research Laboratory (ARL) in coordination with the Armaments Research Development and Engineering Center (ARDEC); design an experimental rocket motor intended to provide increased missile range via enhanced burning rate; create and evaluate novel aerodynamic structures to support extended range and maneuvering missile applications.			
FY 2017 Plans: Will continue to evaluate performance enhancement capability of physical burn rate augmentation for minimum signature propellant to improve volume efficiency of tactical missiles; will 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; will design and characterize rocket nozzle and case insulation materials to improve insulation and erosive properties, and reduce cost for tactical missile applications; will investigate and evaluate laser welding and light weight coating technology to reduce cost and manufacturing time for composite structures; will design and validate logic/algorithms that integrate target classification and identification information available from multiple weapon platform sources; will use target classification			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
information to construct fuze commands for tailorable effects payloads that optimize target defeat, minimize collateral effects, and facilitate multi-use, tailorable effects weapons; and will 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.			
Title: Multi-Role Missile Technology ***Description:*** This effort evaluates critical technology and designs component for future affordable rockets and missiles to provide overwhelming defeat of conventional and asymmetrical threats in all environments. Successful technologies are matured and demonstrated in PE 0603313A, Project 263/704. ***FY 2015 Accomplishments:*** Utilized data fusion to incorporate new navigation technologies into missile navigation algorithms aiding GPS and inertial navigation for operation in GPS-denied environments; evaluated propulsion energy management technologies, and performed trade studies of new payload technologies for long-range missiles; conducted component performance trade studies; continued laboratory testing of component designs for lightweight multi-role modular missiles that can be integrated onto various sizes of unmanned aviation systems as well as manned rotary wing platforms; investigated alternate component technologies for seeker and guidance electronic unit design cost reduction and with no performance degradation; evaluated and assessed new alternate lightweight/high strength materials to increase weapon survivability and reduce soldier weight burden. ***FY 2016 Plans:*** Refine detailed trade studies identifying critical technologies for next-generation close combat, precision missile systems enabling increased range for a man portable system; develop and evaluate 3-dimensional precision targeting software for Soldier, maneuver and fire support weapon applications; perform requirements definition, component trade studies, and preliminary component designs for a precision, maneuverable missile to meet emerging mission needs; design and develop critical components (hardware and software) that support an open systems architecture to enable modular designs of guided and unguided missiles. ***FY 2017 Plans:*** Will 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 will integrate modular missile technology components and open system architecture into subsystems and verify subsystem performance in bench-level and laboratory environments.	3.809	8.543	6.099
Title: Large Long Range Future Fires	2.926	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Description: This effort evaluates and provides technologies and performs necessary trade studies to provide the key components for maturation and demonstration for a large long range future fires missile in PE 0603313A Project 263. ***FY 2015 Accomplishments:*** Continued to update propulsion models and conduct analyses of large long-range fires propulsion system requirements; designed, fabricated, and performed initial testing of propulsion sub-systems that will enable Large Long Range Future Fires capability.			
Title: Air Defense Missile Technologies (formerly Counter Unmanned Aerial Systems and Counter Cruise Missile) ***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 unmanned aerial systems (UAS) and cruise missile systems. This work supports efforts in PE 0603313A, Projects 263 & 704. ***FY 2015 Accomplishments:*** Evaluated and analyzed component technologies to support the counter UAS mission and expand efforts to include tactical level air threats with 360 degree coverage. Began component level modeling and simulation and evaluated system architecture concepts. ***FY 2016 Plans:*** Continue development of critical interceptor technologies and components such as seeker, control system, mission computer, power system, and propulsion; design and implement 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:*** Will continue establishment, fabrication and evaluation of critical air defense interceptor technologies and components: control system, mission computer, and power system; and will continue to design and implement software application algorithms for maneuver and fire support weapon targeting.	2.983	6.188	5.176
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 Plans:***	-	2.000	3.610

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Conduct component/subsystem trade studies to determine subsystem requirements for an affordable discriminate extended range precision missile; begin design of critical component technologies identified through subsystem trade studies. ***FY 2017 Plans:*** Will 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: advanced propulsion, seekers/sensors, fire control, datalink, guidance, navigation and controls, and maneuverable airframes, and platform integration.			
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 Plans:*** Design and begin fabrication of advanced solid rocket motors to increase range for long range fires missiles; explore novel navigation techniques specific to the timelines required for long range fires missiles in GPS denied environments; integrate and conduct 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; conduct full scale tests against select military operations and urban terrain targets to characterize lethality. ***FY 2017 Plans:*** Will 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 will continue performance evaluations of blast/fragmentation warhead and hardened multi-point fuze designed to produce effectiveness against both point and area targets.	-	6.586	4.126
Accomplishments/Planned Programs Subtotals	45.144	45.053	44.313

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*	**Project (Number/Name)** 214 / *Missile Technology*

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
G05: *MISSILE TECHNOLOGY INITIATIVES (CA)*	-	16.000	8.500	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 2015	FY 2016
Congressional Add: Program Increase	16.000	8.500
FY 2015 Accomplishments: Program increase for missile technology research		
FY 2016 Plans: Program increase for missile technology research		
Congressional Adds Subtotals	16.000	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: PB 2017 Army	Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	37.464	38.028	28.803	-	28.803	22.774	21.346	18.378	24.986	-	-
042: *High Energy Laser Technology*	-	27.464	29.428	28.803	-	28.803	22.774	21.346	18.378	24.986	-	-
NA5: *Advanced Weapons Components (CA)*	-	10.000	8.600	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 project 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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Previous President's Budget	38.513	29.428	28.803	-	28.803
Current President's Budget	37.464	38.028	28.803	-	28.803
Total Adjustments	-1.049	8.600	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	8.600			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.049	-			

Exhibit R-2, RDT&E Budget Item Justification: PB 2017 Army	Date: February 2016
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602307A / *Advanced Weapons Technology*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2015	FY 2016
Project: NA5: *Advanced Weapons Components (CA)*		
Congressional Add: *Directed energy/thermal management program increase*	10.000	8.600
Congressional Add Subtotals for Project: NA5	10.000	8.600
Congressional Add Totals for all Projects	10.000	8.600

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
042: *High Energy Laser Technology*	-	27.464	29.428	28.803	-	28.803	22.774	21.346	18.378	24.986	-	-

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 2015	FY 2016	FY 2017
Title: Solid State Laser (SSL) Effects	5.579	5.426	3.557
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 2015 Accomplishments: Upgraded SSLT lethality data collection capability to collect better represented lethality data to improve lethality models and better predict integrated high energy laser demonstration performance; used lethality data to improve laser weapon system battle management capability against Rockets, Artillery, and Mortar (RAM) and Unmanned Aerial System (UAS) targets; began collecting lethality data on targets to support planning for the upcoming High Energy Laser Mobile Demonstrator (HEL MD) 50kW class demonstration, modeling, and effects simulation analysis; continued validation and analysis of atmospheric effects on the propagation of a 1.06 micron SSL.			
FY 2016 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Conclude SSLT lethality data collection effort on representative RAM and basic UAS targets; conduct field performance validation, analyze results; develop plan and schedule, and procure targets for follow-on threats to include cruise missiles and advanced UAS threats; and analyze data and provide 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; 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.			
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 2015 Accomplishments:*** Began joint advanced beam control effort with other services and the HEL JTO to develop beam control component technology that is capable of meeting desired performance requirements; continued development of an All Weather Tracker with the goal to be able to track RAM and UAS targets in adverse weather to augment the tracking and aim point maintenance of a High Energy Laser Weapon System; completed analysis and subscale experiments using segmented mirrors to demonstrate improved ability to correct wavefront errors in a high energy laser. ***FY 2016 Plans:*** Validate performance of an advanced, tactical, light-weight beam director during representative tactical laser engagements; validate advanced tracking concepts and atmospheric beam compensation at the SSLT in representative tactical laser engagements; continue development of All-Weather Tracker technologies, to include algorithms and component hardware; complete analysis and subscale experiments using segmented mirrors to validate improved ability to correct wavefront errors in a HEL; develop breadboard All-Weather Tracker that integrates algorithms and the sensor sub-system that will be compatible with the HEL MD; develop data fusion algorithms and high frame rate image processing hardware and software; and develop 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	3.916	3.283	3.781

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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.			
Title: High Efficiency Laser Development ***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 2015 Accomplishments:*** Completed critical design review on efficient high power rugged laser for future integration into HEL MD; purchased long lead items, including the multi-dielectric grating, 112 channel fiber array holder, polarization-maintaining high power fibers, fiber coupled pump diodes, fiber isolators and pump combiner, and narrow line-width seed sources; completed design and spectral beam combiner component risk reduction experiments to support scaling up to 100kW; began initial subcomponent integration; conducted improved laser thermal management risk reduction experiments and verified performance of two-phase cooling approach to improve magazine depth; completed fabrication of one double-density Fiber Laser Module (FLM) and two additional fiber laser modules to support the manufacture readiness review; completed maintenance concept plan for the high power rugged laser line replaceable units. ***FY 2016 Plans:*** Complete laser subcomponent fabrication and integration; complete fabrication of 28 double density high power fiber laser modules (>2kW each); demonstrate maintenance concept plan in the laboratory with the laser line replaceable units; complete the laboratory performance validation of the rugged, high efficiency laser to at least the ~50kW power level; begin preparation of laser for integration, develop detailed integration plan for laser subsystem integration into an Army platform, and complete all the interface specifications; validate performance of a laser system integrated refrigerant cooling subsystem; and complete 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.	16.341	19.102	20.015
Title: HEL Research and Development and Concepts Analysis Laboratories	1.628	1.617	1.450

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 2015 Accomplishments:*** Completed Adaptive Optics (AO) performance demonstrations of advanced AO algorithms for transition to the HEL MD AO system; purchased pump diodes and scaled electric/Radio Frequency discharge sources and began diode pump gas laser scaling experiments; developed models of space environment effects on small spacecraft; performed orbital assessments of nanosatellite spacecraft and constellation concepts; and investigated concepts in support of space, missile, rocket, and mortar defense. ***FY 2016 Plans:*** Complete preliminary design and conduct experiments to verify Xenon laser design is scalable for potential next generation electric laser compactness, efficiency, and thermal management properties; begin algorithm development and establish an experimental testbed for non-beacon-based 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; characterize AO performance limits during horizontal beam propagation in a relevant environment; investigate radar enhancements to HEL MD fire control loop; refine models of space environmental effects on small satellites; and investigate 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.			
Accomplishments/Planned Programs Subtotals	27.464	29.428	28.803

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
NA5: *Advanced Weapons Components (CA)*	-	10.000	8.600	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 2015	FY 2016
Congressional Add: Directed energy/thermal management program increase	10.000	8.600
FY 2015 Accomplishments: Directed energy/thermal management program increase		
FY 2016 Plans: Directed energy/thermal management program increase		
Congressional Adds Subtotals	10.000	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: PB 2017 Army	Date: February 2016
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*

COST ($ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	26.505	27.862	27.688	-	27.688	28.631	31.345	31.970	32.609	-	-
C90: *Advanced Distributed Simulation*	-	20.262	21.041	20.589	-	20.589	23.203	24.820	25.315	25.821	-	-
D02: *Modeling & Simulation For Training And Design*	-	6.243	6.821	7.099	-	7.099	5.428	6.525	6.655	6.788	-	-

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: PB 2017 Army					Date: February 2016
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 2015**	**FY 2016**	**FY 2017 Base**	**FY 2017 OCO**	**FY 2017 Total**
Previous President's Budget	27.423	27.862	28.288	-	28.288
Current President's Budget	26.505	27.862	27.688	-	27.688
Total Adjustments	-0.918	0.000	-0.600	-	-0.600
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.918	-			
• Adjustments to Budget Years	-	-	-0.600	-	-0.600

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
C90: *Advanced Distributed Simulation*	-	20.262	21.041	20.589	-	20.589	23.203	24.820	25.315	25.821	-	-

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 program element 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 2015	FY 2016	FY 2017
Title: Live, Virtual, Constructive (LVC) Simulations	7.912	8.124	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. Develop methods and technologies that are transitioned to Program Element (PE) 0603015A/Project S29.

FY 2015 Accomplishments:
Developed the architecture for the Soldier-Centered Army Learning Environment (SCALE); investigated the 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; completed and implemented component designs of natural and man-made synthetic terrain effects such as craters, building rubble, etc.; and assessed the training effectiveness of the attained levels of realism and immersion. The SCALE architecture integrated mobile and social media

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
technologies to enhance the training effectiveness of individual Soldiers. The architecture development is consistent with the Army Learning Model (ALM). ***FY 2016 Plans:*** Investigate 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; research, develop and assess the use of the SCALE architecture in relevant use cases supporting the ALM; develop 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; validate the effectiveness of select experimental tools and virtual environments on Soldier learning during joint and coalition training and mission rehearsal exercises; research the effect of technologies such as interoperable performance assessment, mobile application use, data analytics, and social media on the 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 develop 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: Modeling and Simulation Training Technologies ***Description:*** This effort investigates future simulation and training technologies across a variety of domains, requirements, and applications. It will include new technologies that can be applied to military domains such as live and medical training. 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. The effort will address the training effectiveness of the simulation and training technologies being researched and how they will contribute to the overall effectiveness of new training capabilities. ***FY 2015 Accomplishments:*** Continued next generation Multiple Integrated Laser Engagement System (MILES) research in support of a live training program of record for home station and combat training center supporting Force-on-Force (FOF) training for Brigade Combat Teams (BCTs), battalions, companies, platoons, squads, crews and individuals; researched, measured, and characterized real human	6.311	6.528	6.650

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
and simulated human tissue to derive performance requirements for future simulated tissue; researched embedded and external sensors to autonomously measure student performance inside and outside of the body; and investigated advanced three-dimensional (3D) visualization technologies and measured the impact on anatomical cognition for medical training. ***FY 2016 Plans:*** Design the laser component of the next generation MILES for a live training program of record at home stations and combat training centers supporting Force-on-Force training for BCTs; apply measured tissue properties to experimental simulations and validate its performance; apply sensors to simulated tissue to objectively measure human performance and validate tissue performance; research and develop 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.			
Title: Collaborative and Immersive Environment Technologies ***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 2015 Accomplishments:*** Conducted research to develop best practices for automatically authoring, assessing, managing instruction, and deploying computer based tutoring systems (CBTS); designed and developed domain models (e.g., content, human interaction, and assessment standards); determined effectiveness for CBTS technologies; developed techniques and identified technologies that will lower the skills required to author CBTS (ALM); continued to incorporate research results in GIFT tutoring framework to enhance overall training effectiveness; and conducted follow-on efficacy studies on virtual world and game-based learning techniques for a blended learning approach to conduct kinetic and non-kinetic training. ***FY 2016 Plans:*** Conduct initial user validation studies of usage of CBTS authoring tools to supplement traditional classroom training with computer-guided tutoring per ALM; conduct research to expand intelligent tutoring system domain models to represent Army training domains; research, develop, and evaluate instructional models for unit-level team tutoring. ***FY 2017 Plans:***	5.056	5.189	5.764

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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.			
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 2015 Accomplishments:*** Researched and designed a simulation architecture that supports the development of a Soldier as a System simulation; developed novel simulation solutions to link and synchronize models of human and system components; and established groundwork for implementing echelons of metrics to create trade space data for analyzing factors to include Soldier individual and team performance, system effectiveness, training requirements, and cost. ***FY 2016 Plans:*** Investigate the design of a simulation architecture that supports the development of a Soldier as a System simulation; investigate novel simulation solutions developed to link and synchronize models of human and system/equipment components; and develop 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.	0.500	0.600	0.600
Title: Future Autonomy – Optimizing Training Strategies ***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	0.483	0.600	0.600

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
(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. ***FY 2015 Accomplishments:*** Researched and developed simulation architectures that represent current and future autonomous systems. The architectures incorporated current autonomous system attributes that enable the evaluation of their effects on individual and unit training. ***FY 2016 Plans:*** 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.			
Accomplishments/Planned Programs Subtotals	20.262	21.041	20.589

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
D02: *Modeling & Simulation For Training And Design*	-	6.243	6.821	7.099	-	7.099	5.428	6.525	6.655	6.788	-	-

A. Mission Description and Budget Item Justification

This effort 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 program element 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 2015	FY 2016	FY 2017
Title: Immersive Technology Environments	3.122	3.411	3.550
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 2015 Accomplishments: Researched techniques for human spatial perception within virtual environment; investigated the effect of display configurations on social responses to virtual humans to increase immersive effects; and investigated outfitting displays with audio transducers and using psycho-acoustical effects methodologies to increase immersion and effectiveness during interactions with virtual humans.			
FY 2016 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Investigate 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; experiment with adding mobile communication devices to the virtual human architecture to examine long-term interactions with virtual coaches and mentors; and determine 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.			
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 2015 Accomplishments:*** Researched and evaluated situational authoring tools designed to enable non-technical users to create content for inclusion into intelligent tutoring systems; investigated new animation and natural language techniques for the development of web-based virtual humans to support on-line immersive learning environments; and explored techniques to rapidly recreate training scenario content. ***FY 2016 Plans:*** Conduct research to develop learner models for adaptive training environments focusing on strategies to increase learner attention and engagement; and investigate 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.	3.121	3.410	3.549
Accomplishments/Planned Programs Subtotals	6.243	6.821	7.099

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*	**Project (Number/Name)** D02 / *Modeling & Simulation For Training And Design*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2017 Army	Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	71.811	98.439	67.959	-	67.959	65.912	61.755	61.083	62.560	-	-
C05: *Armor Applied Research*	-	30.796	29.251	24.380	-	24.380	22.751	17.503	13.397	13.783	-	-
H77: *National Automotive Center*	-	15.371	15.738	15.936	-	15.936	15.359	16.322	19.369	19.761	-	-
H91: *Ground Vehicle Technology*	-	25.644	23.850	27.643	-	27.643	27.802	27.930	28.317	29.016	-	-
T26: *Ground Vehicle Technologies (CA)*	-	0.000	9.600	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-
T31: *NAT'L AUTO CENTER APP RES INIT (CA)*	-	0.000	20.000	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, instrumentation and survivability packaging concepts to achieve superior survivability/protection for Soldiers and military ground vehicles. Additional efforts include design and develop enhanced technologies for active protection countermeasures against advanced and emerging threats, and will be designed in such a way that the technologies will be easily integrated into the established 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: PB 2017 Army	**Date:** February 2016
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*

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 2015**	**FY 2016**	**FY 2017 Base**	**FY 2017 OCO**	**FY 2017 Total**
Previous President's Budget	72.861	68.839	69.739	-	69.739
Current President's Budget	71.811	98.439	67.959	-	67.959
Total Adjustments	-1.050	29.600	-1.780	-	-1.780
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	29.600			
• Congressional Directed Transfers	-	-			
• Reprogrammings	0.500	-			
• SBIR/STTR Transfer	-1.550	-			
• Adjustments to Budget Years	-	-	-1.780	-	-1.780

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2015**	**FY 2016**
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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
C05: *Armor Applied Research*	-	30.796	29.251	24.380	-	24.380	22.751	17.503	13.397	13.783	-	-

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 2015	FY 2016	FY 2017
Title: Advanced Armor Development:	15.252	12.744	9.893
Description: The objective of this effort is to design, integrate and validate performance of advanced armor systems to defeat single and multiple chemical and kinetic energy (CE and KE) emerging threats for combat and tactical vehicles. These systems include base armor (small arms / medium caliber opaque B-kits and transparent), 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 2015 Accomplishments: Continued characterization of next generation advanced lightweight combat and tactical vehicle armors; performed environmental and ballistic testing, along with modeling and simulation integration analysis for combat and tactical objective threat-based laminate and encapsulated kinetic energy armor systems (B-Kits); performed risk mitigation and integration analysis for combat			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
vehicle threat-based passive, reactive and electromagnetic chemical energy armor systems (C-Kits); explored adaptive armor applicability and related platform integration techniques to reduce armor weights while increasing protection levels. ***FY 2016 Plans:*** Develop new armor materials and mechanisms to achieve an overall ground vehicle armor subsystem weight reduction of 10-15%. Mature 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. Conduct advanced passive kinetic energy armor and explosive reactive armor integration experiments for component integration, and system seams and attachments. Begin validation of advanced passive B-Kits, and advanced reactive armor systems for C-Kits by conducting ballistic experiments. Mature 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.			
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. This effort creates the laboratory capability needed to enable expeditious research and development of blast-mitigating technologies. 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 2015 Accomplishments:*** Researched and conducted experiments to evaluate the use of advanced passive and active approaches to mitigate the effects of underbody blast threats in areas such as seats, restraints, energy absorbing materials and active blast countermeasures; conducted tests to evaluate the integration of exterior and interior blast mitigation solutions onto the Occupant-Centric Protection (OCP) demonstrators, vehicle systems, test assets and/or sub-systems; verified and validated occupant-centric design guidelines/ standards, M&S tools, test procedures, laboratory processes, experimentation capabilities; researched means to allow mechanical	9.284	6.541	3.335

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
countermine tactics or products to be more effective; supported testing of new instrumentation capabilities being developed by other programs such as the Warrior Injury Assessment Manikin (WIAMan) Generation 1 blast dummy. ***FY 2016 Plans:*** Develop blast mitigation technologies to include seats, restraints, flooring and structures at the component and sub-system level to verify sub-system interactions. Evaluate passive and active technology solutions using Finite Element Modeling and Simulation tools along with sub-system laboratory tools to develop a variety of concepts. Verify component and sub-system design guidelines and evaluation techniques. Mature the WIAMan in the laboratory environment through durability, repeatability and sensitivity tests of the WIAMan device components and system. Begin 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 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.			
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 2015 Accomplishments:*** Provided enhanced capabilities for protected mobility and survivability optimization to support combat modeling, and assessment of technologies that provide enhanced protection with minimum increase in system burdens; provided enhanced assessment methodologies for quantifying and mitigating post-engagement damage and crew casualties from effects such as blast and fire; and provided enhanced assessment methodologies for mobility and survivability on protected mobility. ***FY 2016 Plans:***	3.253	1.000	2.202

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Leverage the enhanced protected mobility optimization and assessment tools and methodologies developed previously to design future vehicle concepts, optimize protection and mobility technologies to minimize system burdens, and identify 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.			
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 2015 Accomplishments:*** Conducted initial investigation of video and data architectures that enable the efficient integration of DVE SA technologies; conducted feasibility analysis, trade studies and interface definitions of DVE SA technologies from aviation and commercial applications onto ground combat and tactical vehicles utilizing advanced vehicle digital architectures. ***FY 2016 Plans:*** Integrate aviation-based DVE sensors onto an Indirect Vision Driving vehicle through the Integrated Digital Video System (IDVS); develop algorithms that determine how to take World Model information from various sources and overlay that information in real time on the Indirect Vision Driving screens to aid the vehicle operator in visually occluded environments. Conduct 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.	3.007	7.040	7.242
Title: Vision Protection	-	1.926	1.708

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 Plans:*** Conduct damage threshold and damage mechanism studies on current day cameras and optical systems from short-pulsed laser threats. Improve 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.			
Accomplishments/Planned Programs Subtotals	30.796	29.251	24.380

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H77: *National Automotive Center*	-	15.371	15.738	15.936	-	15.936	15.359	16.322	19.369	19.761	-	-

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 2015	FY 2016	FY 2017
Title: Power, Energy and Mobility:	4.234	4.236	4.309

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 2015 Accomplishments:
Collaborated with the Department of Transportation, to leverage activities in the active safety and autonomy areas to exploit efficient fuel vehicle operation over military platforms and duty cycles. Performed next generation of joint activities under the AVPTA vehicle efficiency alliance with the Department of Energy (DOE). Developed modeling and simulation of advanced vehicle technologies with DOE AVPTA activities. Investigated energy efficient lubrication potential to produce a significant savings in overall fuel efficiency for our fleets. This work was coordinated with PE 0603125A.

FY 2016 Plans:

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Continue joint activities with Department of Energy and Department of Transportation to exploit fuel efficient vehicle operation for military platforms and duty cycles. Continue to support the transition of technology to/from industry and government. Develop and mature fuel cell systems for initial integration experiments of fuel cells onto vehicles. Investigate 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 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.			
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, and advanced vehicle networking and 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 2015 Accomplishments:*** Continued to partner with the Department of Transportation to leverage both traditional crash worthiness as well as active safety and autonomous driving. Other areas of collaborative research included component safety, human interface and distracted driving technologies. Proceeded to leverage the commercial automotive and trucking research and development centers at the original equipment manufacturer (OEM) and tier suppliers to bring reliable, affordable technology solutions to our military ground vehicle fleet. ***FY 2016 Plans:*** Continue to leverage commercial automotive and trucking research and development centers to transition reliable, affordable technology solutions to our military ground vehicle fleet. Continue to leverage industry's state of the art vehicle electrification and open vehicle architecture standards and facilitate transition into military ground vehicles. Continue to research and develop autonomous vehicle standards with industry and other government organizations. Mature intelligent ground vehicle systems and develop mission payloads for dual use applications to increase efficiencies. Investigate solutions to transition commercial fuel cell technologies to military ground systems. ***FY 2017 Plans:***	11.137	11.502	11.627

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 (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.			
Accomplishments/Planned Programs Subtotals	15.371	15.738	15.936

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H91: *Ground Vehicle Technology*	-	25.644	23.850	27.643	-	27.643	27.802	27.930	28.317	29.016	-	-

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 2015	FY 2016	FY 2017
Title: Pulse Power:	3.369	3.423	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 2015 Accomplishments:
Fabricated electrified armor and pulse power components for validation at the subsystem level against MIL-STD-810G test procedures, thermal, rain and salt testing, shock/vibration and performance testing. Conducted road testing and soldier-in-the-loop testing with electrified armors for safety and performance validation.

FY 2016 Plans:
Complete 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. Begin pulse power system laboratory testing to validate the

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
power system performance needed for electromagnetic armor threat defeat. Complete 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 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 2015 Accomplishments:*** Investigated waste heat recovery applications for military vehicles to increase system efficiencies. Investigated grill designs for greater cooling capability. Designed and fabricated a high power density, low heat rejection, fuel efficient engine technology that is scalable and modular for combat and tactical vehicles to address increasing vehicle weights, commonality and thermal burden issues that are not available in commercial-off-the-shelf engines specific to military applications. ***FY 2016 Plans:*** Design and develop an advanced heat exchanger and efficient fan subsystem to increase cooling capabilities and fuel efficiency. Design waste heat recovery system for military vehicle applications to provide additional onboard electrical power. Mature 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.	4.283	5.122	5.895
Title: Power Management Technologies:	2.823	2.583	2.625

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Description: This effort investigates power management technologies, software, and implementation approaches. Technologies include Alternating Current (AC) to 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 2015 Accomplishments:*** Tested Silicon Carbide-based power electronics for power conversion, distribution, and control to implement the next generation, open, non-proprietary electrical power architecture for military ground vehicles. Continued development of the power management algorithms and software for the next generation power architecture. Demonstrated power management and advanced electrical power architecture fuel savings gains of at least 10% on a 72-hour combat mission. Began integration of the components for the next generation power architecture into a Systems Integration Lab (SIL) to demonstrate SiC and automated power management. ***FY 2016 Plans:*** Complete development of the next generation power architecture and corresponding system design using SiC power electronics and low cost computers. Integrate high and low voltage power components into a 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.			
Title: Power Electronics, Hybrid Electric and Onboard Vehicle Power (OBVP) Components:	1.328	1.218	1.288
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 2015 Accomplishments:***			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Investigated approaches to further electrify and control parasitic vehicle automotive loads and increase efficiency; modeled and simulated tracked vehicle performance with OBVP technologies integrated; investigated approaches to implement mild hybrid (system that integrates electric machines to assist internal combustion engines for propulsion) capabilities on OBVP equipped vehicles. Investigated intelligent engine start/stop strategy, architecture and controls to dramatically reduce engine idling. ***FY 2016 Plans:*** Design and develop 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 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.			
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 2015 Accomplishments:*** Investigated technologies that would enable a 20kW fuel cell APU; began initial experiments on increasing fuel cell components resistance to sulfur; began initial experiments of high power rotary engine APU designs; began to investigate noise mitigation solutions for high power rotary engine APUs. ***FY 2016 Plans:*** Design and develop high power rotary engine technologies to increase the power density up to two times current power densities of other heavy fueled internal combustion engines. Investigate and design 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:***	3.052	1.909	1.298

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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.			
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 2015 Accomplishments:*** Performed analysis of previously tested short fiber materials; optimized fiber orientation and validated through laboratory testing; analyzed the potential of combining short fiber material with novel other fillers to further reduce black carbon in the elastomer material; performed laboratory testing of optimized compounds. ***FY 2016 Plans:*** Fabricate elastomer samples with optimized compounds for durability evaluation. Validate durability evaluation data with predictive fatigue models. Perform 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.	0.662	0.662	0.662
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 2015 Accomplishments:*** Extended the capabilities of active safety systems for military vehicles to reduce soldier injury due to vehicle accidents and rollovers; advanced capabilities for manned/unmanned teaming; enhanced command and control software to enable single-	7.592	6.614	9.832

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
operator control of multiple unmanned systems; refined algorithms, sensor fusion, dismounted behaviors, and soldier-robot interaction capabilities to enable mission planning and execution in dynamic environments; further developed interoperability profiles and mission package integration; developed capabilities for longer-duration/higher-tempo operations. ***FY 2016 Plans:*** Develop autonomous behaviors for mounted and dismounted ground vehicle systems that are adaptable to different missions and environments. Develop advanced cognitive control through feedback coupling of Soldier-Unmanned Ground Vehicle system capabilities and behavior at neural, neurocognitive, and sociocognitive levels. Mature 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 tactical resupply perception models, location fidelity of supply, and software algorithms to meet dynamic stockage objectives to improve throughput.			
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 2015 Accomplishments:*** Integrated novel battery materials (anode, cathode, electrolyte, and separators) into battery cells designed to fit into existing military battery form-factors (ex: 6T); improved existing advanced 6T battery pack prototypes and designs by incorporating new cell technologies and refining their battery management systems, control algorithms, and physical construction for shock & vibration and Electro-Magnetic Interference (EMI); improved 6T battery designs for manufacturability, commonality and cost reduction; validated improved 6T designs against latest battery & vehicle safety and performance requirements. ***FY 2016 Plans:***	2.535	2.319	2.475

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Design and develop advanced cell level materials to fit into standardized military battery form factors such as 6T. Design improved advanced standardized battery prototypes by incorporating advanced cell materials. Develop and mature 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.			
Accomplishments/Planned Programs Subtotals	25.644	23.850	27.643

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
T26: *Ground Vehicle Technologies (CA)*	-	0.000	9.600	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 2015	FY 2016
Congressional Add: Program Increase	-	9.600
FY 2016 Plans: 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: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
T31: *NAT'L AUTO CENTER APP RES INIT (CA)*	-	0.000	20.000	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 2015	FY 2016
Congressional Add: Alternative Energy Research ***FY 2016 Plans:*** This is a Congressional Interest item	-	20.000
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: PB 2017 Army	Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	83.610	117.801	85.436	-	85.436	89.905	90.842	93.219	94.325	-	-
H80: *Survivability And Lethality Technology*	-	83.610	92.801	85.436	-	85.436	89.905	90.842	93.219	94.325	-	-
HB1: *SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)*	-	0.000	25.000	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: PB 2017 Army	**Date:** February 2016
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 2015**	**FY 2016**	**FY 2017 Base**	**FY 2017 OCO**	**FY 2017 Total**
Previous President's Budget	85.575	92.801	87.540	-	87.540
Current President's Budget	83.610	117.801	85.436	-	85.436
Total Adjustments	-1.965	25.000	-2.104	-	-2.104
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	25.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.965	-			
• Adjustments to Budget Years	-	-	-2.104	-	-2.104

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2015**	**FY 2016**
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: PB 2017 Army												Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H80: *Survivability And Lethality Technology*	-	83.610	92.801	85.436	-	85.436	89.905	90.842	93.219	94.325	-	-

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 2015	FY 2016	FY 2017
Title: Underbody Blast & Occupant Protection	6.247	5.314	2.220

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 PE 0602601A (Armor Applied Research) and PE 0603005A (Combat Vehicle Survivability).

FY 2015 Accomplishments:
Continued to develop experimental and modeling approaches to identify relevant physical parameters affecting the loading from buried blast and penetrator threats; developed experimental tools to track complex occupant motion during a blast event and validate associated numerical models; and developed and validated momentum transfer concepts to absorb energy from underbody threats through a combination of materials development and structural design research.

FY 2016 Plans:

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Investigate structural damage and response due to buried blast and penetrator threats and propose novel protection solutions to defeat these threats; design active mechanisms including momentum transfer and other technologies to mitigate lower-extremity injuries. ***FY 2017 Plans:*** Will investigate active and adaptive concepts, such as threat detection, to protect against buried blast and penetrator threats.			
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 smaller, cheaper and lighter munition components enabling low-collateral-damage precision munitions for future asymmetric operations in military operations on urban terrain (MOUT). ***FY 2015 Accomplishments:*** Advanced individual component guidance technologies and simulation capability by evaluating, at bench level, candidate actuator technologies, guided spin-stabilized munition technologies, and flow control technologies; and assessed concepts using multiple technologies for guided munitions in global positioning system (GPS) denied environments. ***FY 2016 Plans:*** Develop nonlinear methods to assess flight dynamics and stability and to enhance control algorithm development for precision munitions; evaluate inertial navigation technologies to improve abilities to hit moving targets; and develop new electro-optic/ infrared-based navigation capabilities and assess associated in-lab maneuver performance of precision munitions. ***FY 2017 Plans:*** Will 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.	2.907	3.812	3.758
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 2015 Accomplishments:***	10.177	10.538	8.307

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Explored and exploited innovative methods for efficient synthesis and scale-up of disruptive energetic materials; developed novel energetic ingredients using chemical and high pressure synthesis methods; used these ingredients in new formulations for transition to weapons applications with significantly improved performance; developed multi-phase explosive and initiation concepts to maximize energy transfer to target; developed and validated numerical model of muzzle flow field in small caliber weapon systems to enable control of overpressure; and validated propulsion models and methods to enable 6 to 10 times solid propellant burn-rate/regression-rate enhancement using nitrate ester and novel propellant ingredients. ***FY 2016 Plans:*** Mature 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; design laboratory experimental capabilities for evaluating gram-scale quantities of disruptive energetic materials to determine potential for further exploration and scale-up; explore methods to reduce power required to accelerate rounds for medium-caliber weapons using computational fluid dynamics (CFD)-based models; and design 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:*** Will 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.			
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 2015 Accomplishments:*** Developed small caliber soldier-portable mechanisms to defeat combatants in high-risk urban scenarios; validated robust kinetic energy penetrator concept with reduced mass while maintaining armor defeat capabilities to reduce life-cycle costs and enable defeat of future threats; and validated modeling and simulation capabilities to assess novel lethality concepts. ***FY 2016 Plans:*** Develop energy requirements and associated mechanisms to adapt large caliber performance to a shoulder fired system; investigate new mechanisms that take advantage of increased energy availability from enhanced gun efficiencies and new	6.232	5.691	5.670

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
energetic materials to increase lethal capabilities; and explore new concepts to utilize lower energies on target to achieve effects ranging from non-lethal to lethal. ***FY 2017 Plans:*** Will 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.			
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 2015 Accomplishments:*** Developed new methodologies to characterize behind-helmet blunt trauma and assessed the associated injury incapacitation probabilities for soldiers; developed predictive ammunition vulnerability methodologies (vulnerability to unintended ammunition detonation due to incoming round); performed improvements to tools, techniques, and methodologies for ballistic survivability/ lethality analysis ensuring analysis tools are relevant and credible for developmental and modernized Army systems; and conducted validation and verification of ballistic vulnerability and lethality codes. ***FY 2016 Plans:*** Mature methodologies that characterize behind-helmet blunt trauma and assess the associated injury incapacitation probabilities for soldiers; mature predictive ammunition vulnerability methodologies (vulnerability to unintended ammunition detonation due to incoming round); mature 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 conduct validation and verification of mature ballistic vulnerability and lethality codes ***FY 2017 Plans:*** Will 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.	12.566	10.202	8.273
Title: Multi-Threat Armor Formulations and Designs	20.121	23.188	21.649

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 2015 Accomplishments:*** Investigated ceramic laminate characteristics to identify/gain iterative improvements for protection during future threat/armor engagement processes; investigated concepts for defeat of very large shaped charge threats, including developing an understanding of how various defeat mechanisms interact as threat size increases; explored novel explosive reactive armor mechanisms for defeat of advanced threats; developed new approaches for advanced kinetic energy (KE) multi-hit defeat for vehicle sides and front; validated protection capabilities against both explosively formed penetrators (EFPs) and rocket propelled grenades (RPGs) by utilizing multiple defeat mechanisms in a single system; developed new mechanisms to enable defeat of both KE and chemical energy (CE) threats in a single system; and supported transitions to the Army Tank Automotive Research, Development and Engineering Center (TARDEC) PE 0602601A/Project C05 and PE 0603005A /Project 441). ***FY 2016 Plans:*** Develop understanding of limiting mechanics of multiple impacts from advanced KE threats and expand our functional library of defeat mechanisms that are independent of size, severity, or configuration regarding shaped charge equipped warheads; develop defeat concepts that greatly expand protection from vast array of kinetic energy and shaped charge weapons; and continue support for transitions to the U.S. Army 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:*** Will 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.			
Title: Adaptive and Cooperative Protection Technologies ***Description:*** This effort pursues a holistic approach toward achieving significant weight reduction and defeat of future threats by utilizing real-time information, combined with threat knowledge, to provide ever-increasing protection. This approach includes the fusing of individual vehicle capabilities of armor, underbody blast protection, active protection systems (APS), and advanced	-	-	2.795

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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:*** Will assess current sensor/warner/tracker technologies that can warn of attack and identify threats of interest (such as 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.			
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) PPE concepts that are informed by the human effects during impact and blast events. ***FY 2015 Accomplishments:*** Developed an objective blunt trauma test methodology for helmets using a combination of experimental and modeling approaches, exploring relationships to injury mechanisms; and explored the use of covers and surface coatings on ceramic performance for monolithic and flexible body armor concepts. ***FY 2016 Plans:*** Explore novel helmet concepts that provide both ballistic and blunt trauma protection by incorporating understanding of ballistic impact on curved structures fabricated from structural composites; explore light fabric solutions for protection from secondary blast fragments; explore novel ceramic configurations for protection against advanced kinetic energy rounds; and develop computational methodologies to support development of these technologies. ***FY 2017 Plans:*** Will 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.	2.919	3.758	6.561
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. ***FY 2015 Accomplishments:***	3.316	3.299	0.797

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Pursued novel concepts to enable significant increases in impact velocities, reduced muzzle pressures, and increased accuracy in small caliber systems; and developed understanding of alternate approaches to achieve long range precision for 50 caliber man-portable systems. ***FY 2016 Plans:*** Investigate concepts and validate models to achieve significantly higher muzzle velocities in small caliber weapons; and mature 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:*** Will 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 2015 Accomplishments:*** Initiated validation and verification testing of the first generation WIAMan demonstrator; designed and initiated development of the WIAMan data acquisition system; transferred knowledge and tools for use in Live Fire Test & 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; and transfer of responsibilities and funding (PE 0602787A/Project 869) from MRMC to ARL effective FY15. ***FY 2016 Plans:*** Complete validation and verification testing of the first whole-body WIAMan demonstrator; fabricate and integrate the WIAMan data acquisition system into the manikin; revise prototype manikin design and prepare technical data package for fabrication of the next generation prototype manikin and award fabrication contract; conduct program assessment milestone review; conduct injury medical research in a blast driven environment; transfer knowledge and tools for use in Live Fire Test and Evaluation and other under-body blast survivability efforts; and conduct research to establish human tolerance to the under-body blast loading environment and development of human injury probability curves. ***FY 2017 Plans:***	10.500	11.393	8.808

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Will 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.			
Title: Vulnerability Assessment of Technologies	4.500	8.630	8.706

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 2015 Accomplishments:
Selected developmental (current and emerging) technologies; identified spectrum of threats for technologies identified and selected high-priority threats for investigation; designed, developed and matured assessment methods and tools; designed and conducted experiments that demonstrated technology vulnerabilities; and identified mitigation strategies for vulnerabilities discovered. Technology selection was influenced by highest priority/highest potential payoff technologies taking in to account intelligence research, such as that performed at the National Ground Intelligence Center (e.g., high priority threat/capabilities, threat horizon, characterization of contested environment, etc.); and designed assessments with environments and factors that were used to demonstrate vulnerabilities (electronic warfare, cyber security, survivability, lethality and system of systems). Candidates and technologies included Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) and Network Modernization, Active Protection Systems, unmanned ground vehicle/unmanned aerial vehicle technologies, hostile fire detection technologies, digital radio frequency memory (DRFM) for countermeasures/counter-countermeasures, or optics technologies that benefited from reduction of optical augmentation.

FY 2016 Plans:
Conduct vulnerability assessments on critical 6.2 technologies based on Army priorities. These assessments identify very early-on, possible vulnerabilities and shortcomings of emerging technologies and influence future Science and Technology (S&T) investment decisions resulting in the fielding of more robust systems. Candidate technologies will be considered across all Army S&T portfolios.

FY 2017 Plans:
Will 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

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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.			
Title: Active Protection Modeling and Technologies	4.125	6.976	3.217
Description: This effort supports the development of APS technologies and common architecture to reduce vehicle weight while significantly increasing protection against current and emerging advanced threats by reducing reliance on armor through other means such as sensing, warning, and active countermeasures. The APS common architecture will provide adaptable APS solutions that can be integrated across Army vehicle platforms as required. This research includes the development of new modeling and simulation capabilities along with supporting experimental and theoretical approaches to enable active protective systems. This effort includes integrated information (e.g., battlefield geography, threat launch detection and tracking) and intelligence to inform protection optimization, requiring collaboration across multiple Army organizations. 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 2015 Accomplishments:*** Explored threat independent hybrid/adaptive mechanisms; developed and validated initial computational model to examine interactions of sensors and defeat mechanisms against ballistic threats; and developed active protection concepts, including countermeasures, threat warning capabilities, and dynamic threat maps. ***FY 2016 Plans:*** Develop ATGM flight models; conduct warhead damage experiments into larger threats with different warhead explosives; develop softkill countermeasure models; complete integration of softkill and hardkill components and controller algorithms into an overarching softkill/hardkill simulation; integrate results into Research, Development, and Engineering Command (RDECOM)-level APS simulations suite. ***FY 2017 Plans:*** Will 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.			
Title: Swarming Weapons Technologies	-	-	4.675

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
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 GPS denied environments) through the use of highly collaborative teaming and distributed intelligence, perception, estimation, and control theories and technologies. ***FY 2017 Plans:*** Will 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.			
Accomplishments/Planned Programs Subtotals	83.610	92.801	85.436

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
HB1: *SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)*	-	0.000	25.000	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 2015	FY 2016
Congressional Add: Program Increase ***FY 2016 Plans:*** This is a Congressional Interest Item	-	20.000
Congressional Add: Improved Armor Technologies ***FY 2016 Plans:*** 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: PB 2017 Army	Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	3.865	3.866	3.923	-	3.923	3.994	4.018	4.098	4.180	-	-
552: *Smoke/Novel Effect Mun*	-	3.865	3.866	3.923	-	3.923	3.994	4.018	4.098	4.180	-	-

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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Previous President's Budget	3.970	3.866	3.923	-	3.923
Current President's Budget	3.865	3.866	3.923	-	3.923
Total Adjustments	-0.105	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.105	-			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
552: *Smoke/Novel Effect Mun*	-	3.865	3.866	3.923	-	3.923	3.994	4.018	4.098	4.180	-	-

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 Program Element (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.

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 2015	FY 2016	FY 2017
Title: Advanced Obscurants	1.399	1.426	1.468
Description: This effort investigates new materials and compounds to enable safe, effective screening of personnel and equipment.			
FY 2015 Accomplishments: Investigated spectrally selective materials and new microwave obscurant materials.			
FY 2016 Plans: Investigate spectrally selective materials and new microwave materials. Investigate materials for advanced bispectral obscurants.			
FY 2017 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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.			
Title: Obscurant Enabling Technology ***Description:*** This effort investigates distribution technologies for various obscurants. ***FY 2015 Accomplishments:*** Continued to study dissemination of new low hazard visual obscurants for grenade applications. Initiated explosive dissemination technology studies. Initiated efforts to investigate vulnerability of various technologies to obscurant/target defeat effects. Identified technologies of interest; conducted initial analysis with the intent of evaluating/assessing effects. ***FY 2016 Plans:*** Continue to study explosive dissemination variables to understand key factors such as obscurant dispersal. Continue 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.	1.000	1.000	1.000
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 2015 Accomplishments:*** Investigated linkages of spectroscopic signatures developed in Fiscal Year (FY) 2012 with compositional analysis of explosives using analytical protocols developed in FY13-14 in order to improve the attribution power of optical systems. ***FY 2016 Plans:*** Investigate 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:***	1.466	1.440	1.455

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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.			
Accomplishments/Planned Programs Subtotals	3.865	3.866	3.923

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: PB 2017 Army	Date: February 2016
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602623A / *Joint Service Small Arms Program*

COST ($ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	6.633	5.487	5.545	-	5.545	5.608	5.565	5.675	5.789	-	-
H21: *Jt Svc Sa Prog (JSSAP)*	-	6.633	5.487	5.545	-	5.545	5.608	5.565	5.675	5.789	-	-

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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Previous President's Budget	6.850	5.487	5.545	-	5.545
Current President's Budget	6.633	5.487	5.545	-	5.545
Total Adjustments	-0.217	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.217	-			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H21: *Jt Svc Sa Prog (JSSAP)*	-	6.633	5.487	5.545	-	5.545	5.608	5.565	5.675	5.789	-	-

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 Program Element (PE) support the Lethality portfolio.

Work in this project is related to, and fully coordinated with, efforts in 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 2015	FY 2016	FY 2017
Title: Advanced Small Unit (Squad) Small Arms Technology Concepts ***Description:*** This effort was originally titled Joint Service Small Arms Program (JSSAP) Mini Grand Challenge. It addresses future small arms technology investments including new materials, high power energy sources, miniaturization techniques, and reduction of weapon moving components. ***FY 2015 Accomplishments:*** Experimented with selected phosphors properties that provide one-way luminescence capability for 5.56mm and 7.62mm caliber ammunition; investigated and evaluated suppressor designs to decrease flash and acoustic detection; validated adaptive solid lubricants to decrease required weapon maintenance and transitioned results to PE 0603607A.	0.500	-	-
Title: Small Arms Material and Process Technology ***Description:*** This effort addresses state of the art material substrates and surface coatings to improve reliability, reduce maintenance and improve weapon diagnostics through embedded technology. ***FY 2015 Accomplishments:***	2.429	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Experimented with selected phosphors properties that provide one-way luminescence capability for 5.56mm and 7.62mm caliber ammunition; investigated and evaluated suppressor designs to decrease flash and acoustic detection; validated adaptive solid lubricants to decrease required weapon maintenance and transitioned results to PE 0603607A.			
Title: Advanced Future Small Arms Concept Exploration ***Description:*** This effort addresses the investigation and design of enabling technologies transitioned from Basic Research (6.1) efforts in the areas of ballistics, energetics, future weapon and fire control sensors in order to extend individual soldier engagement ranges and maintain squad lethality overmatch; and optimize caliber performance to match mission sets. ***FY 2015 Accomplishments:*** Investigated and evaluated advanced small arms kinetic ammunition designs; designed new small caliber weapons component technologies to obtain increased range and accuracy, decreased weight, improved target acquisition and engagement while reducing weapons recoil and suppressing weapon signature; investigated futuristic small arms weapon systems proposed by the West Point Futures Studies and generated technology development plans, trade-off analysis, and concept designs.	3.704	-	-
Title: Weapon System and Enablers ***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 Plans:*** Investigate and evaluate advanced materials, coatings and weapon system designs in order to reduce weight, mitigate recoil, and decrease weapon signature; mature suppressor designs to reduce gun flash and acoustic signatures; investigate futuristic small arms weapon systems proposed by the West Point Futures Study and generate technology plans, trade-off analyses, and concept gun designs. ***FY 2017 Plans:*** Will 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.	-	1.742	1.860
Title: Small Arms Ammunition Research ***Description:*** This effort addresses the design and evaluation of ammunition with reduced weight, signature, fouling and contaminants as well as improved terminal performance and improved performance against soft and hard targets.	-	1.278	3.046

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
FY 2016 Plans: Investigate and evaluate ammunition designs in order to increase probability of hit and probability of incapacitation/hit; optimize caliber and configuration to defeat personnel targets at extended ranges, with or without protection; conduct trade studies to support energetic materials for propulsion, breaching ammo and tagging and marking; design, fabricate or evaluate advanced armor piercing 5.56mm and advanced kinetic energy ammunition in collaboration with ARL. ***FY 2017 Plans:*** Will investigate and assess ammunition propulsion technologies to increase muzzle velocity that meet safety constraints (noise and muzzle pressure) yet increase velocity/muzzle energies: 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.			
Title: Optics and Fire Control ***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 Plans:*** Investigate and evaluate 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	-	1.841	-
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 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	-	0.626	0.639

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 2017 Plans:*** Will 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.			
Accomplishments/Planned Programs Subtotals	6.633	5.487	5.545

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: PB 2017 Army	Date: February 2016
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*

COST ($ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	62.131	83.340	53.581	-	53.581	50.022	61.509	63.213	65.739	-	-
H18: *Weapons & Munitions Technologies*	-	18.346	20.974	21.749	-	21.749	23.480	27.907	25.269	29.600	-	-
H19: *Asymmetric & Counter Measure Technologies*	-	6.761	13.212	14.924	-	14.924	9.482	13.904	20.002	17.834	-	-
H1A: *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE*	-	25.000	35.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-
H28: *Warheads/ Energetics Technologies*	-	12.024	14.154	16.908	-	16.908	17.060	19.698	17.942	18.305	-	-

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 the lethality of United States weapons as well as directed energy (DE) capabilities and subsystems to support the weaponization of High Power Radio Frequency (RF) systems. 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: PB 2017 Army	Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Previous President's Budget	63.057	48.340	57.038	-	57.038
Current President's Budget	62.131	83.340	53.581	-	53.581
Total Adjustments	-0.926	35.000	-3.457	-	-3.457
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	35.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.034	-			
• SBIR/STTR Transfer	-0.892	-			
• Adjustments to Budget Years	-	-	-3.457	-	-3.457

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2015	FY 2016
Project: H1A: *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE*		
Congressional Add: *Program Increase*	25.000	35.000
Congressional Add Subtotals for Project: H1A	25.000	35.000
Congressional Add Totals for all Projects	25.000	35.000

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H18: *Weapons & Munitions Technologies*	-	18.346	20.974	21.749	-	21.749	23.480	27.907	25.269	29.600	-	-

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 Program Element)PE) support the Army Science and Technology Lethality 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 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 2015	FY 2016	FY 2017
Title: Novel Propulsion Technology for the Future	3.614	3.856	3.388
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 2015 Accomplishments: Conducted initial experiments on non-ammonium perchlorate propellant formulations for rocket assisted projectile indirect fire solutions; designed and developed propellant technologies for next generation artillery and tank applications; scaled up materials for advanced propellants, igniters and combustible materials for propellant charges.			
FY 2016 Plans: Conduct evaluation of extended range 120mm mortar fire in a round designed to double (2x) the range; produce co-extruded gun propellant for direct and indirect fire applications; perform 30mm fires of coated propellant for improved ballistic performance and extended range with lower sensitivity to temperature; increase the burn rate at low temperature and maintain high temp burn rate			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
resulting in more range over the temp spectrum and increased accuracy due to less propellant variation; formulate new materials for extended range artillery applications. ***FY 2017 Plans:*** Will 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 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.			
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 2015 Accomplishments:*** Investigated multiple promising innovative weapon technologies that could provide greater lethality; developed weapon technologies that incorporated emerging materials (e.g. nanotechnology, additive manufacturing); developed weapon, munition and fire control technologies that support advanced forms of engagement, such as collaborative munitions. ***FY 2016 Plans:*** Continue to investigate innovative weapon technologies that could provide lethality improvements such as nanostructured materials for high strain rate applications and counter Unmaned Aeriel Systems (UAS) system analysis; develop weapon technologies that incorporate new materials (e.g. nanotechnology, additive manufacturing); develop weapon, munition and fire control technologies that support advanced forms of engagement, such as collaborative multi-role weapons and munitions. ***FY 2017 Plans:*** Will 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.	2.130	1.409	1.497
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 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 2015 Accomplishments:***	0.991	0.988	-

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Matured and validated the improved aerodynamic shapes, propellant, guidance, navigation and control, auto pilot and low pressure gas technologies, into 60mm/120mm mortar projectiles with a goal of up to a 75% increase in range with guidance; conducted an experimental flight of a guide to hit projectile at 75% increased range. ***FY 2016 Plans:*** Investigate hybrid (155mm projectile with the incorporation of base fins and lifts/control surfaces) technologies for artillery indirect fire application; design control surfaces to achieve extended ranges; conduct 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 2015 Accomplishments:*** Validated inertial sensor array design and processing algorithms developed; conducted various experiments with the long-wave/ near-infrared (IR) imagers used for terminal guidance in GPS denied environments. Nature of the experiments was to collect real time imagery data for the purpose of navigation algorithm development. This effort was conducted in collaboration with AMRDEC through the Aided Target Recognition (ATR) Working Group and with ARL through a technology transition agreement. This effort spun out component technologies that will be evaluated and matured in the fully coordinated effort of the same name in PE/ Project 0603004A/232. ***FY 2016 Plans:*** Continue 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; perform evaluation of the image processing navigation algorithm using the modeling and simulation developed. This effort is being conducted in collaboration with AMRDEC through the Aided Target Recognition (ATR) Working Group and with ARL through a technology transition agreement. . ***FY 2017 Plans:*** Will 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.	3.282	2.675	2.962
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.	0.694	0.747	-

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
FY 2015 Accomplishments: Investigated, designed, developed and validated printed electronics, energetics, and power sources for Munitions and other armament applications; matured materials and printing techniques to add capabilities to munitions and fuze systems, while reducing the size, weight, and cost of conventional electronics; conducted 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 the integrated project team and technical working groups. ***FY 2016 Plans:*** Investigate, design and adopt commercial-off-the-shelf (COTS) hardware to print electronics and energetics for use in munitions and power sources for munitions and other armament applications; establish materials and printing techniques to add capabilities to munitions and fuze systems, while reducing the size, weight, and cost of conventional electronics; conduct 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 is being 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 2015 Accomplishments:*** Matured the concepts of an extended range armament system; continued the investigation of unconventional materials and processes to allow a new system to have no significant weight increase compared to existing systems; developed a detailed design of a lightweight armament system for use in extended range weapons that addressed the current Army capability gaps with minimal system impact. ***FY 2016 Plans:*** Continue to mature the concepts of an extended range armament system; conduct initial verification of models through lab scale prototypes and testing; and evaluate the various technology concepts based on the capabilities the integrated system provides. ***FY 2017 Plans:***	1.021	2.287	2.814

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Will 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.			
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 2015 Accomplishments:*** Investigated and developed armament technologies to provide protection to vital National assets including vehicles, facilities, weapons, and personnel; developed precision weapons, munitions and fire control technologies to reduce collateral damage to non-combatants; developed armament technologies that provide greater standoff distance between incoming threats and vital assets. ***FY 2016 Plans:*** Continue to investigate and design armament technologies to provide protection to vehicles, facilities, weapons, and personnel; develop 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:*** Will 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.	2.840	3.512	0.588
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 2015 Accomplishments:*** Investigated candidate projectile and weapon systems technologies that provided extended range by leveraging novel materials, innovative propulsion technologies and advanced design concepts. ***FY 2016 Plans:***	1.887	3.500	2.500

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
This effort is being conducted in concert with the Extended Range Indirect Fire Weapon Technology effort mentioned above. These new technologies apply 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 will be 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.			
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 2015 Accomplishments:*** Identify candidate technologies that can be used to facilitate advanced high-g target sensing/classification that are miniaturized, integrated and packaged into existing fuze form factors which are currently not available for advanced munitions; new miniaturized safe and arm architectures that can enable the next generation of enhanced lethality; and advanced fuze setting for size and weight reduction through advanced electronic packaging schemes and efficient setting technologies; investigate viability of candidate technologies; develop initial concepts and determine feasibility to known technological gaps; and evaluate innovative miniaturized munitions power source candidate technologies. ***FY 2016 Plans:*** Explore robust airburst fuze technology concepts for increased accuracy in multi-purpose rounds; develop 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; investigate alternative fuze setting methodologies to more efficiently transfer and store power and data to smart indirect fire projectiles; investigate multi-point initiation concepts applicable for Insensitive Munitions applications; investigate innovative munitions power source candidate technologies for medium and large caliber munitions. These technologies support the Joint Munitions Program Technical Coordinating Group (TCG – 5 and TCG-10) and the Joint Fuze Technology Program (JFTP). ***FY 2017 Plans:*** Will 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	1.887	2.000	2.000

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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.			
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 will investigate 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.	-	-	6.000
Accomplishments/Planned Programs Subtotals	18.346	20.974	21.749

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H19: *Asymmetric & Counter Measure Technologies*	-	6.761	13.212	14.924	-	14.924	9.482	13.904	20.002	17.834	-	-

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 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 PE support the Army Science and Technology Lethality Portfolio.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering 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 2015	FY 2016	FY 2017
Title: Novel Battlefield Effectors	1.490	1.753	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 2015 Accomplishments:
Developed the most promising effector technologies for transition to advanced development; investigated size, weight, power and cost benefits of those technologies; explored the use of non-traditional technologies in new applications.

FY 2016 Plans:
Continue to investigate the most promising effector technologies such as Hostile Fire Detection Mortar Blast Attenuation, and Counter-Counter Measure Technologies ready for transition to advanced development; investigate size, weight, power and cost benefits of those technologies in new applications; explore the use of disruptive technologies that can be applied to current and future precision guided direct and indirect fired munitions.

FY 2017 Plans:

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Will 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 ***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 2015 Accomplishments:*** Developed the most promising technologies to protect munitions and weapons technologies against emerging threat countermeasure technologies; explored disruptive directed energy as a means of providing CCM; investigated most promising CCM technologies for transition to advanced development. ***FY 2016 Plans:*** Conduct experimentation of CCM technologies for gun launched munition components in a relevant laboratory environment. ***FY 2017 Plans:*** Will 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.	1.265	1.445	1.463
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 2015 Accomplishments:*** Developed novel methods and algorithms for improved ballistics, for data and image processing, and for sensing battlefield, weapon and target environment; investigated small, accurate, survivable weapon orientation sensors, technologies and	2.011	2.000	2.000

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
compensation methodologies to improve the weapon pointing; refined concepts for hardware and software architectures for optimum physical and functional integration, increased commonality, lower weight, and faster engagement times. ***FY 2016 Plans:*** Evaluate and integrate acquisition and engagement technologies which support 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; investigate miniaturized and multifunctional electronic components to reduce SWaP-C, and increase commonality of hardware, software and operation across indirect fire systems; perform architecture trade-off analyses that allow for efficient, real-time fusion of information and data. ***FY 2017 Plans:*** Will further mature extended range tracking and miniaturization of components for use in GPS-denied environments as well as further maturing navigation and pointing technologies/compensation components; validate improved conventional munition accuracy and communication techniques for in-flight interface/control with smart munitions.			
Title: High Powered Radio Frequency ***Description:*** The use of High Power Radio Frequency (RF) has been demonstrated to provide desired target effects against various targets; however such systems are still too large and consume too much power to make them tactically useful for Army applications. This effort will focus on addressing the SWaP - C of High Power RF systems and their components so as to allow tactically useful systems. ***FY 2015 Accomplishments:*** Focused on reducing antenna size for high power RF transmission; investigated high dielectric constant composites (nano-dielectrics) to produce 60-80% size reduction in antenna array elements; developed the antenna array elements to transmit known RF waveforms (frequency, pulse width, and amplitude) to cause a desired target effect of interest. ***FY 2016 Plans:*** Continue investigation of high dielectric constant composites (nano-dielectrics) to achieve the desired size reduction of the high power antenna array to include validation; design, fabricate and evaluate transistor technologies, such as laterally diffused metal oxide semiconductor (LDMOS) field-effect transistors, for highly efficient solid state transmitter applications. ***FY 2017 Plans:*** Will 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.;	1.995	2.007	2.002

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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.			
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 Plans:*** Investigate 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 investigate different designs of tamper deterrence and anti-tamper technologies such as obscuration and non-lethal technologies. ***FY 2017 Plans:*** Will 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.	-	2.000	2.000
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 Plans:*** Investigate advanced materials and technologies that optimize small arms fire control architecture at a reduced weight; develop and assess advanced small arms technologies for improved target handoff; evaluate technologies that detect and provide threat indicators and potential targets; investigate 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:*** Will 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.	-	4.007	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:***	-	-	0.900

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Will 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.			
Accomplishments/Planned Programs Subtotals	6.761	13.212	14.924

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H1A: *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE*	-	25.000	35.000	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 2015	FY 2016
Congressional Add: Program Increase ***FY 2015 Accomplishments:*** Program increase for weapons and munitions technology research. ***FY 2016 Plans:*** Program increase for weapons and munitions technology research.	25.000	35.000
Congressional Adds Subtotals	25.000	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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H28: *Warheads/ Energetics Technologies*	-	12.024	14.154	16.908	-	16.908	17.060	19.698	17.942	18.305	-	-

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 Program Element (PE) support the Army Science and Technology Lethality Portfolio.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering 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 2015	FY 2016	FY 2017
Title: Scalable Warhead Technology	4.294	6.193	5.931
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 2015 Accomplishments: Matured designs and conducted experiments in the area of spin compensated shaped charges, enhanced fragmentation, directional lethality and multiple explosively formed penetrator (MEFP) warheads; validated scalable technologies as they relate to lethal to less than lethal effects.			
FY 2016 Plans: Design and develop 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. Design and test brass board designs for shaped charge, explosively formed penetrator (EFP) and blast fragmentation with targeted lethality; determine, through modeling and simulation, the applicability of tunable/tailorable effects for adaptable warheads for future artillery, mortars and medium caliber munitions.			
FY 2017 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Will 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, designs will be applied to warhead subsystem for validation. In addition, will 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.			
Title: Explosives Research ***Description:*** This effort develops high energy/high performance, multi-purpose insensitive munitions (IM) explosives. ***FY 2015 Accomplishments:*** Formulated and processed combined effects and high efficiency explosives; validated affordable new energetic binders for enhanced blast formulations; investigated new synthetic processes to enable low-cost, high energy solid crystal explosive ingredients; matured processing techniques for nano-enhanced organic energetics formulations; conducted experiments on electrically-induced tailored energy release for proof of chemistry-based variable warhead fragmentation and the possibility of an on/off energetic capability. This effort was conducted in collaboration with ARL through both the integrated project team and technical working groups. ***FY 2016 Plans:*** Continue to investigate single step nano-enhanced explosive munitions with greatly reduced shock sensitivities; validate lethality and fragmentation concepts; investigate scale up high pressure synthesis chemistry of disruptive energetic materials; validate high efficiency explosive concepts in munition systems. This effort is being conducted in collaboration with ARL through both the integrated project team and technical working groups. ***FY 2017 Plans:*** Will 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.	3.968	4.861	7.877
Title: Material Development for Water Purification	0.248	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Description: This effort originated from a material development for armament systems and was found to have a dual use application. The effort (also known as Adaptive Armament Reactive Interface Domains/AARID) is intended to provide a capability to enhance contingency basing water efficiency via recycling with secondary contributions to reduction of waste and power. Other advantages are on improved sustainment, greater logistics flexibility, and reduced Warfighter threat from supply convoys. ***FY 2015 Accomplishments:*** Designed and developed a method to collect real time data to determine flow rates and validate water purity values; conducted experiments to compare coated filters to uncoated filters to determine the benefits of the coating in purifying water.			
Title: Explosives Safety for Automated Base Camp Planning ***Description:*** This effort determines data interoperability requirements between explosive safety and base camp planning software tools; designs an integrated tool that increases explosive safety for base camps by managing the risk due to interaction between changes in Net Explosive Weight, geography, facilities and force structure. ***FY 2015 Accomplishments:*** Developed and evaluated ammunition explosives safety planning and management modules within the base camp planner design architecture. This task is fully coordinated with the effort of the same name in PE/Project 0603001A/543.	0.497	-	-
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 2015 Accomplishments:*** Assessed formulations and functional concepts for dazzler, cloud and seeker countermeasures; conducted experiments on dazzler flares and prepare for flight tests; conducted experiments on cloud countermeasures; analyzed dazzler and cloud countermeasure performance using experiment and simulation results for application to multiple aircraft and aspect angles; identified threats and developed concepts for seeker countermeasure. ***FY 2016 Plans:*** Refine dazzler countermeasure (CM) formulations along with additional flight testing. Refine dazzler model and simulation (M&S) algorithms as well; cloud countermeasure undergoing final prototype formulation in full up system level demonstrations on aircraft; update M&S algorithms for cloud countermeasure; test advanced countermeasure initial formulations and flare concepts against hardware in the loop threat seekers; develop digital M&S algorithms. ***FY 2017 Plans:***	3.017	3.100	3.100

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Will 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.			
Accomplishments/Planned Programs Subtotals	12.024	14.154	16.908

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: PB 2017 Army	Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	72.442	64.301	56.322	-	56.322	58.884	59.914	61.784	63.827	-	-
EM4: *Electric Component Technologies (CA)*	-	17.000	9.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-
EM8: *High Power And Energy Component Technology*	-	12.800	12.143	11.416	-	11.416	11.599	11.645	11.878	12.116	-	-
H11: *Tactical And Component Power Technology*	-	11.519	11.810	8.714	-	8.714	8.295	7.602	7.791	7.987	-	-
H17: *Flexible Display Center*	-	0.555	1.136	2.356	-	2.356	2.393	2.449	2.499	2.549	-	-
H94: *Elec & Electronic Dev*	-	30.568	30.212	33.836	-	33.836	36.597	38.218	39.616	41.175	-	-

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, microwave, 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: PB 2017 Army	**Date:** February 2016
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 2015**	**FY 2016**	**FY 2017 Base**	**FY 2017 OCO**	**FY 2017 Total**
Previous President's Budget	73.422	55.301	57.002	-	57.002
Current President's Budget	72.442	64.301	56.322	-	56.322
Total Adjustments	-0.980	9.000	-0.680	-	-0.680
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	9.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.980	-			
• Adjustments to Budget Years	-	-	-0.680	-	-0.680

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2015**	**FY 2016**
Project: EM4: *Electric Component Technologies (CA)*		
Congressional Add: *Silicon Carbide (SiC) Research-Army Research Laboratory*	12.000	-
Congressional Add: *Advanced Intelligent Battery Eliminator / Lithium-ion Capacitor Material Research, Electrolyte and Cell Experimentation*	5.000	-
Congressional Add: *Program Increase*	-	9.000
Congressional Add Subtotals for Project: EM4	17.000	9.000
Congressional Add Totals for all Projects	17.000	9.000

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
EM4: *Electric Component Technologies (CA)*	-	17.000	9.000	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 2015	FY 2016
Congressional Add: Silicon Carbide (SiC) Research-Army Research Laboratory ***FY 2015 Accomplishments:*** Continue research on SiC power devices and power components.	12.000	-
Congressional Add: Advanced Intelligent Battery Eliminator / Lithium-ion Capacitor Material Research, Electrolyte and Cell Experimentation ***FY 2015 Accomplishments:*** Researched and validated cutting-edge battery eliminator technology based on lithium ion ultracapacitor designs.	5.000	-
Congressional Add: Program Increase ***FY 2016 Plans:*** This is a Congressional Interest Item	-	9.000
Congressional Adds Subtotals	17.000	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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
EM8: *High Power And Energy Component Technology*	-	12.800	12.143	11.416	-	11.416	11.599	11.645	11.878	12.116	-	-

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 2015	FY 2016	FY 2017
Title: High Power and Energy Technologies	1.182	1.233	-
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 2015 Accomplishments:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Investigated and developed advanced wide band gap materials and devices, for operation above 20 kV to support survivability, lethality systems, and high voltage microgrid application requirements; researched and evaluated high voltage packaging needs; and continue research into wide bandgap semiconductors identified in Fiscal Year (FY) 2014. ***FY 2016 Plans:*** Validate a 20 kV device and packaging concept; continue to extend the voltage and current capabilities of power switching components through modeling and research of the materials and fabrication processes; and research 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 2015 Accomplishments:*** Investigated techniques for power scaling CW and pulsed mid-wave IR sources for IR countermeasure (IRCM) applications; and explored laser materials with enhanced thermal conductivity that will provide superior ability to meet stringent Army size, weight, and power requirements for counter rocket, artillery, and mortar (C-RAM) applications. ***FY 2016 Plans:*** Explore novel fiber designs to increase power while preserving high beam quality for enabling laser directed energy weapons; and investigate 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.	1.874	2.000	2.000
Title: Directed Energy (DE) /Electronic Attack Technologies/Spectrum Sensing and Exploitation	6.135	2.325	2.346

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Description: Investigate and evaluate emerging technologies related to DE technology, electronic warfare (EW) survivability/ lethality, operations in the contested and congested electromagnetic environment, and supporting DE and EW high power components, with the goal of enhancing the survivability/lethality of Army platforms. ***FY 2015 Accomplishments:*** Determined the susceptibility of emerging threat electronics (to include those related to improvised explosive devices (IEDs)) to electronic attack; characterized parameters for use in the development of neutralization waveforms and techniques; investigated Digital Radio Frequency Memory technology and its effects on jamming/counter-jamming applications; and developed cognitive RF architecture and baseline hardware and algorithms for sensing and exploiting electromagnetic environment. ***FY 2016 Plans:*** Design electronic protection (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.			
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 2015 Accomplishments:*** Investigated both gallium nitride (GaN) and silicon carbide (SiC) based electronic components for device reliability and characterize these materials; investigated advanced control and diagnostic methods for power switches to improve fault tolerance and efficiency; conducted applied research on next-generation materials and fabrication methods for compact power switching components that provide high voltage, high current, and/or high frequency operation; and investigated and developed advanced power semiconductor devices and modules, for operation above 20kV and at high currents. ***FY 2016 Plans:***	3.000	3.234	3.464

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Evaluate and design reliability models of current and next generation wide bandgap electronic components for device enhancements; determine advanced control and diagnostic methods for power switches to improve fault tolerance and efficiency; and validate 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 GaN-based wide-bandgap materials; investigate available GaN power device architectures and material systems for improving reliability of electronic switching devices; and validate physics-based models of high-voltage power devices to enable improved performance and understanding of device operation.			
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 2015 Accomplishments:*** Conducted applied research in power management, intelligent controls, and diagnostics for power conversion modules and circuits to provide more efficient, robust, and reliable power delivery and conversion for vehicle and micro-grid power applications; investigated advanced behavior based Tactical Energy Network control and prediction techniques; and researched distributed control strategies to enable more robust and failure resistant grids (e.g. utilized swarm (hive or colony) control, where each member of the swarm represents a specific piece of equipment). ***FY 2016 Plans:*** Research and validate a universal power conversion concept that converts any input power to any output power for vehicle and micro-grid power applications; investigate controls for Tactical Energy Network control and prediction techniques allowing any power input to feed any output power specification; design distributed control and storage models to demonstrate more reliable and failure tolerant grids; and investigate 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	0.609	3.351	3.606

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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.			
Accomplishments/Planned Programs Subtotals	12.800	12.143	11.416

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H11: *Tactical And Component Power Technology*	-	11.519	11.810	8.714	-	8.714	8.295	7.602	7.791	7.987	-	-

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.

This project supports Army science and technology efforts in the Command, Control, Communications and Intelligence, Soldier/Squad and Innovative Enablers 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, Development and Engineering Command (RDECOM), Communications-Electronics Research, Development, and Engineering Center (CERDEC), Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Title: Tactical Power Generation Technology	6.519	4.673	4.034
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 2015 Accomplishments:*** Matured very high energy density hybrid power sources as a wearable conformal power source; designed a smart Soldier power grid capable of integrating energy storage and power generation devices with smart power management and distribution with little to no user interaction; matured internal components to facilitate a renewable multi-fueled Soldier portable power source; investigated a system to integrate wireless power and energy harvesting technologies into the smart Soldier power grid to reduce cabling and connectors; continued to investigate techniques to increase wireless power transfer efficiency and distance;			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
conducted experiments on novel energy harvesting components to increase efficiency and reduce weight of carried power sources. ***FY 2016 Plans:*** Mature hybrid power sources to increase power and energy densities and reliability for high energy density devices; optimize electrolyte formulations and cathode materials to improve safety for higher energy and power solutions; research existing and novel energy storage and power generation components to ensure their compatibility within the Soldier power grid; increase efficiency and optimize internal components of multi-fueled generator to facilitate development of a smaller, more portable device; investigate various wireless power transfer technologies and increase efficiencies to enhance power transmission distances; research and design interoperable devices capable of utilizing energy harvesting technologies to charge Soldier wearable hybrid power sources to achieve a net-zero energy posture; investigate wireless solution for net-zero energy approach. ***FY 2017 Plans:*** 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.			
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 brass board designs for power management and distribution in support of missions in the 1 watt – 300KW range. Work in this effort is complemented by to PE 0603772A/project 101. ***FY 2015 Accomplishments:*** Developed intelligent power management architecture for mobile power generation grids to enable energy informed operations for integrated command, control, communications, computers, intelligence, surveillance and reconnaissance platforms; designed a system of interconnected power grids of various voltages with multiple controllers using a master/slave control scheme capable of supporting ad-hoc connections and configuration; established standards for renewable power generation and energy storage and incorporated into demonstration grid; established power management protocols and policies for interfacing with mission systems;	5.000	7.137	4.680

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
developed power planning tools and applications for monitoring and controlling grid status; developed advanced 2kW fuel efficient silent power generation systems with greater than 30% fuel to electric efficiencies. ***FY 2016 Plans:*** Investigate new software and physical architectures to more efficiently distribute and manage power across the battlefield while reducing size and weight; develop predictive-analysis modeling software to enhance selection and employment of energy sources during the planning and execution mission phases, respectively; continue investigating techniques to reduce the energy demand of Soldier-worn peripherals; assess draft standards for a centralized micro-grid approach and develop standards for a distributed micro-grid; design 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; 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; design and fabricate 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.			
Accomplishments/Planned Programs Subtotals	11.519	11.810	8.714

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H17: *Flexible Display Center*	-	0.555	1.136	2.356	-	2.356	2.393	2.449	2.499	2.549	-	-

A. Mission Description and Budget Item Justification

The flexible electronics program will conduct applied research on the integration of electronics, power components, and sensors on non-traditional flexible substrates. The program will build upon the two-dimensional flexible electronics towards the integration of electronic components, power systems, and sensors into three-dimensional flexible architectures. The research shall include the testing and analysis of the electronic system and electronic modeling. The applied research shall support the demonstration of Army-relevant sensors on flexible substrates for robust monitoring of the human state. The flexible electronics programs efforts will extend physiological monitoring beyond the single-user, fitness-focused commercial perspective by supporting the Army goal to monitor the Soldier in training environments, determine soldier unique states, apply advance modeling to optimize the team performance based on individual uniqueness, and then apply resource distribution processes in real-time.

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 and the Army Modernization Strategy.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Title: Flexible Electronics Development (previously Flexible Display Center (FDC) and Flexible Electronics Development)	0.555	1.136	2.356
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 architectures. This research supports physiological monitoring to determine soldier-unique states and will be used to optimize team or squad level performance.			
FY 2015 Accomplishments: Designed printable sensor materials and devices that will enable new and enhanced capabilities in areas such as flexible electronic large areas sensors, tagging, tracking, and Soldier monitoring.			
FY 2016 Plans: Design flexible hybrid electronic systems integrating traditional silicon electronics, sensors, and power. The applications will include 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:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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.			
Accomplishments/Planned Programs Subtotals	0.555	1.136	2.356

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H94: *Elec & Electronic Dev*	-	30.568	30.212	33.836	-	33.836	36.597	38.218	39.616	41.175	-	-

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 nanotechnology, 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 Program Element (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 and the Army Modernization Strategy.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Title: Antennas and Millimeter Wave Imaging	8.052	3.490	0.657
Description: This effort designs, characterizes, and validates high performance antenna components and software for multifunction radar and communication systems. Research areas include scanning techniques, broadbanding, beamforming, polarization, platform integration, and affordability.			
FY 2015 Accomplishments: Characterized the performance of millimeter wave transceivers for covert communications and sensing applications; extended and modified microwave radar rain scattering models to frequencies above 200 GHz to support transmission of data through rain and dust; and developed and characterized conformal antennas for non-standard covert vehicle applications.			
FY 2016 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Devise and characterize carbon nanotube antennas woven into the fabric of the soldier's uniform; perform 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 radio frequency (RF) performance; use advanced modeling to characterize electromagnetic performance of antennas and RF devices for Army 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.			
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 2015 Accomplishments:*** Developed and characterized micro-electro-mechanical systems (MEMS) technologies for enabling frequency agile RF systems, mm-scale robotic platforms, and novel MEMS and sensor fusion solutions for enabling position, navigation, and timing in global positioning system (GPS) denied environments; continued investigation of novel stacked two-dimensional (2D) electronic materials (e.g. graphene, molybdenum disulphide, boron nitride) for Army-relevant high performance electronic devices such as flexible and transparent transistors, antennas, oscillators, and amplifiers; developed nanoscale energetic materials for micro-autonomous vehicle propulsion, technology protection, and fuze initiators; optimized magnetic tunnel junction interface with magnetic permeability bits to enhance memory density and read speed; developed MEMS acoustic vector intensity probes for target localization and wind mitigation; and developed intrusion detection algorithm to enhance communication link security. ***FY 2016 Plans:*** Design and characterize MEMS components for cognitive RF systems, low power GPS, and sensor technologies for improved Position, Navigation and Timing (PNT); design and develop hardware and algorithms for distributed sensing, micro autonomous system control and chip scale integration of energetic nanoporous silicon for fuze initiation; characterize digital circuits on flexible stacked 2D electronic materials (e.g. graphene, molybdenum disulphide, boron nitride); and explore and optimize the RF performance of stacked 2D electronic materials. ***FY 2017 Plans:***	2.293	2.127	2.155

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 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.			
Title: Millimeter Wave and Microwave Components and Architectures for Advanced Electronic Systems	6.460	5.267	5.617
Description: This effort researches, designs, and characterizes component materials, structures, devices, and the electromagnetic issues of millimeter wave (mmw) and microwave components and active devices. The goal is to develop components that can enable advanced systems that combine multiple RF functionalities. Additional research will focus on Mobile Ad-hoc Networks (MANETs) operating under severe energy and bandwidth constraints, which are vulnerable to enemy infiltration. The objective is to enhance the survivability of MANETs in tactical environments by investigating advanced security suites for MANET access, authentication, and intrusion detection, as well as security and range extensions in the physical device area using advanced Medium Access Control (MAC) layer techniques. ***FY 2015 Accomplishments:*** Developed and tested multi-function RF components capable of receiving weak signals and threat detection using a combination of advanced processing and hardware architectures; investigated novel thermal management techniques for heat removal in high power amplifiers; and developed and characterized efficient, wideband, secured communications at mmw/terahertz frequencies. ***FY 2016 Plans:*** Investigate trade space for device and circuit performance requirements for application to future radar and sensing systems; correlate 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			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
deployment on resource-constrained devices and wireless/wired networks; and improve situational awareness through event and data reasoning via machine learning and statistical methods.			
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 Plans:*** Research active EO shutter systems that do not need a focal plane to activate and explore their implementation in Army optical systems; explore magneto-optic materials for use in protecting IR systems; investigate ladar concepts for ultra-light or large unmanned air vehicle (UAV) navigation; study 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.	-	2.659	2.780
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 2015 Accomplishments:*** Characterized ultrafast laser spectroscopy techniques, especially multiplex Coherent Anti-Stokes Raman Scattering (CARS), to enable remote explosives detection; explored infrared photothermal technique used in conjunction with laser Doppler vibrometry for energetic-related material detection; and simulated and characterized advanced optical components in a threat detection device for active protection defeat of both kinetic energy and non-kinetic energy targets. ***FY 2016 Plans:*** Conduct spectral analysis investigations of candidate spectroscopic detection technologies to include femtosecond Coherent Anti-Stokes Raman Scattering and infrared photothermal spectroscopy; study functional biomaterials in austere environments including the effect of temperature and other degradation pathways; and study and model 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	0.938	1.128	1.910

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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.			
Title: Power and Thermal Management for Small Systems ***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 2015 Accomplishments:*** Investigated heat management techniques for improving engine waste heat recovery; implemented techniques for thermal interface measurements to characterize heat transfer in novel materials; investigated thermoelectric, pyroelectric, and thermophotovoltaic power generation techniques and materials for applicability in direct power generation; characterized advanced materials for improved fuel conversion efficiency and applied them toward developing improved reaction models; investigated improved techniques for wide bandgap material and device design for power supply and conversion systems; and developed improved models and measurement techniques for prediction of silicon carbide device performance and reliability for high power applications. ***FY 2016 Plans:*** Implement techniques for thermal interface measurements to characterize heat transfer in novel materials; develop compact 3-dimensional integration techniques for power electronic devices; investigate novel methods of improving condensation heat transfer through acoustic excitation and surface enhancement; investigate integration of phase change materials into electronic packages for temperature spike suppression; investigate improved micro-fabrication techniques for microscale power devices to be used in power supply systems; investigate wireless energy conversion techniques for powering wearable and portable devices; develop fabrication processes for stretchable, wearable, and light-weight power components; investigate thermoelectric, pyroelectric, and thermophotovoltaic power generation techniques and materials for applicability in direct power generation; and characterize 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;	3.340	3.374	2.026

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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-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.			
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 2015 Accomplishments:*** Matured the design of devices and integrated circuits including built-in self-test of high speed integrated circuits based upon leading-edge group IV and III-V semiconductor materials; and investigated emerging electronics and prognostics and diagnostics strategies for microgrid energy and power applications. ***FY 2016 Plans:*** Explore emerging materials, components, and circuits that enable low energy and power efficient RF devices; design novel integrated circuits that provide improvements in power efficiencies, linearity, and noise; and explore system/chip constraints for ultra-linear performance to enable Soldier-level communication in contested RF environments.	2.028	1.681	-
Title: Advanced Infrared Technology (previously titled 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. Technologies investigated include mercury cadmium telluride (MCT) material grown on silicon (Si) substrates, strained layer superlattices (SLS), and corrugated quantum well infrared photodetector (C-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. Work accomplished under PE 0602709A/project H95 and PE 0601120A/project 31B complements this effort. ***FY 2016 Plans:*** Investigate extremely low-doped MCT IR material grown on domestically available lattice matched substrates for different spectral regions, including short wavelength IR (SWIR) and LWIR applications; study effects of thermal cycle annealing on MCT material as it pertains to dopant species and profiles; study the implementation of resonant features on MCT for higher temperature operation; and characterize and analyze R-QWIP material and devices for improved quantum efficiency and operating temperature. ***FY 2017 Plans:***	-	2.575	1.695

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 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	3.928	3.971	2.837
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 2015 Accomplishments:*** Transitioned thin film thermal batteries to U S. Army Armament Research, Development and Engineering Center (ARDEC) for augmented munitions power; determined transport properties of anion exchange polymers for alkaline fuel cells; investigated components for sodium ion batteries, optimized electrolyte composition for silicon anodes for lithium ion batteries, developed three dimensional (3D) strategies for photosynthetic production of hydrogen for alternative energy applications; experimentally validated models developed through the Multiscale Modeling effort for batteries and fuel cells; and investigate gallium nitride material based devices in addition to silicon carbide based Metal Oxide Semiconductor Field Effect Transistors (MOSFETs) for reliability and operability characterization. ***FY 2016 Plans:*** Characterize and transition 5-volt lithium ion battery electrodes and electrolytes for development of an sample cell for laboratory testing and assessment; investigate novel battery chemistries for Soldier power; characterize new alkaline membranes for fuel cell applications; develop lower cost catalysts for alkaline fuel cells; develop regenerable sulfur sorbents for desulfurization of JP8 at temperatures of 300-400 degrees C; determine 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;			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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.			
Title: Sensor Protection Technologies ***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 RFFEs in contested environments as well as from self-interference challenges where multiple RF systems are operating in close proximity. ***FY 2015 Accomplishments:*** Investigated non-linear electro-optical materials and devices for use in a broad range of sensors (ultraviolet, MWIR, and LWIR) against very short pulse (down to femtosecond) laser threats; investigated materials and novel devices to delay the onset of thermal destruction of optics and optical structures from high energy lasers; improved laser protection by exploring fast electro-optical (EO) shutters, using inorganic crystal-based materials, in conjunction with device tiling to provide increased protection for large aperture sensors; and investigated novel electronic materials to support fast switching devices and power dissipation techniques to protect RF front ends. ***FY 2016 Plans:*** Study 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 mid-wavelength infrared (MWIR) sensor protection; investigate new techniques for protection against CW high energy laser threats; and characterize materials as optical limiters against femtosecond pulsed laser threats across a variety of wavelengths (visible through MWIR).	1.978	1.600	-
Title: Energy Harvesting ***Description:*** This research develops technologies to substantially reduce the number of batteries required to accomplish dismounted Soldier/Squad mission objectives, thereby significantly reducing Soldier-borne load and logistics requirements. Research will explore technologies to harvest electrical power by converting and storing energy via engineered structures and electronic bandgaps, MEMS-based micro-scale power conversion and heterogeneous 3-D 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 2015 Accomplishments:***	1.551	2.340	2.524

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Explored novel thermophotovoltaic devices to achieve high efficiency conversion considering available microcombustors and wavelength-optimized semiconductor devices; investigated plasmonic and meta-materials for enhanced surface catalysis experiments for enhanced energy harvesting from battlefield-scavenged resources; explored options for reducing parasitic losses for military thermoelectrics; and examined pyroelectric materials and models to determine suitability for energy harvesting. ***FY 2016 Plans:*** Study 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; characterize thermoelectric and pyroelectric material properties for energy harvesting; investigate and characterize properties of ultra-energetic (isotopic/isomeric) materials and matched energy conversion structures as a long endurance energy source; and refine 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 capabilities to improve power generation; and investigate integration of novel, stretchable, passive electronics for Soldier energy harvesting applications and wireless energy transfer.			
Title: Energy Efficient Electronics	-	-	5.023
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, efficient electronics research includes RF circuits, devices, materials and wireless power distribution. Energy efficiency improvements will be developed and investigated in support of four key sensor and electronic areas: RF component devices, passively powered components, low-power, long-lived sources, and wireless power transfer. ***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			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
extramural prospects for low-power RF transceiver design techniques using leading node (analog) device technologies; and characterize passive voltage amplification with MEMS (Micro-Electro-Mechanical System) piezo-transformers and multi-layer copper air-core designs, efficient power management of isotopic power sources, and improved coupling in wireless transmission.			
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 Global Positioning System (GPS)-denied environments. The first objective of this research is to improve the size, weight, power, cost and accuracy of current micro-Inertial Measurement Systems (IMS) through the design, fabrication, and testing of MEMS gyroscopes. The second objective is to develop atomic cell disciplined Opto-Electronic Oscillators (OEOs) or laser frequency combs that can be used as ultra-precision local oscillators with improved stability. 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. ***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 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 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.	-	-	2.512
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 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).	-	-	4.100
Accomplishments/Planned Programs Subtotals	30.568	30.212	33.836

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H94 / *Elec & Electronic Dev*

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: PB 2017 Army	Date: February 2016
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*

COST ($ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	44.694	38.807	36.079	-	36.079	37.081	36.800	37.531	38.292	-	-
H95: *Night Vision And Electro-Optic Technology*	-	38.194	33.807	36.079	-	36.079	37.081	36.800	37.531	38.292	-	-
K90: *NIGHT VISION COMPONENT TECHNOLOGY (CA)*	-	6.500	5.000	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 awareness (SA). Project H95 advances infrared (IR) Focal Plane Array (FPA) technologies, assesses and evaluates sensor materials, designs advanced multi-function lasers for designation 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) 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 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: PB 2017 Army	Date: February 2016
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*

B. Program Change Summary ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Previous President's Budget	44.935	33.807	35.556	-	35.556
Current President's Budget	44.694	38.807	36.079	-	36.079
Total Adjustments	-0.241	5.000	0.523	-	0.523
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	5.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	0.470	-			
• SBIR/STTR Transfer	-0.711	-			
• Adjustments to Budget Years	-	-	0.523	-	0.523

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2015	FY 2016
Project: K90: *NIGHT VISION COMPONENT TECHNOLOGY (CA)*		
Congressional Add: *Program Increase*	6.500	5.000
Congressional Add Subtotals for Project: K90	6.500	5.000
Congressional Add Totals for all Projects	6.500	5.000

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H95: *Night Vision And Electro-Optic Technology*	-	38.194	33.807	36.079	-	36.079	37.081	36.800	37.531	38.292	-	-

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 awareness (SA) at an affordable price. Technologies include novel focal plane arrays (FPAs), processing, and electronics. It also includes modeling and simulation to predict performance and to determine operational effectiveness of these technologies. Research focuses on dual band infrared (IR) FPAs necessary to search, identify and track mobile targets in all day/night visibility and battlefield conditions and to improve standoff detection in ground-to-ground and air-to-ground operations. 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 awareness, persistent surveillance and plume/gun flash detection. This project also investigates and improves III-V materials, semiconductor materials formed by a combination of elements from Groups III and V of the periodic table. In addition, this project develops algorithms for multispectral and hyperspectral 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. In Fiscal Year (FY) 2015 and 2016 the Army investment in advanced IR FPA technologies is augmented to ensure a world-wide technological advantage in IR sensors for the United States.

This project supports Army science and technology efforts in the Command, Control, Communications and Intelligence, Soldier, Ground and Air 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 Program Element (PE) is performed by the 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 2015	FY 2016	FY 2017
Title: Distributed Aided Target Recognition (AiTR) Evaluation Center of Excellence	1.768	1.794	2.486
Description: This effort investigates a virtual, distributed capability to interactively process both real and simulated three-dimension (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 2015 Accomplishments: Investigated algorithmic correlation approaches to further reduce false alarms in image based detection and confirmation processing for vehicle systems; designed and developed improved technology for multifunction display capability; continued to			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
investigate signal processing and algorithms for threat detection and tracking that minimizes power consumption, enabling the use of reduced power processors in SWaP constrained environments. ***FY 2016 Plans:*** Investigate inclusion of airborne countermine data in algorithmic correlation approaches to improve image based detection and confirmation; explore new algorithms to improve slew-to-cue and robotic move to a way-point for multifunction display capability; apply low power techniques and look-up libraries to improve signal processing and algorithms for threat detection and tracking to minimize power consumption; augment 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.			
Title: Sensor Modeling and Simulation Technology ***Description:*** This effort investigates, verifies and validates engineering models, measurement techniques and realistic 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 2015 Accomplishments:*** Researched and incorporated sensor performance model and measurement techniques to validate the optimal implementation of target and background signatures in simulation; compared laboratory and field measurements to determine if any errors are introduced by methodology; validated and measured imagery post processing algorithms and subsequent effects on human performance; researched phenomenology and application of imaging sensor modalities across the waveband spectrum, to include three-dimensional (3D) imaging and displays. ***FY 2016 Plans:*** Implement and begin verification and validation of a two dimensional version of sensor performance model and measurement techniques; extend model and measurement methodologies to incorporate non-linear processing to include image quality based metric and advanced image processing algorithms; research modeling and simulation techniques for multi-function or multi-mission sensor systems; research new techniques and implementation methods such as virtual prototyping to support evolution of the modeling and simulation tools development ***FY 2017 Plans:***	5.125	5.222	5.246

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 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.			
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, such as laser designators, laser rangefinders (LRFs), pointers, markers, warning systems and illuminators. 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. ***FY 2015 Accomplishments:*** Designed a multifunction Short Wave Infrared (SWIR) laser breadboard that performs range finding, day-night pointing, and 3D Light Detection and Ranging (LIDAR); extended the laser operating wavelength to Long Wave Infrared (LWIR) by examining alternative laser technology including quantum cascade lasers; researched methods for electronically tuning waveband throughout LWIR band; researched and improved laser diode drivers and associated electronics to improve efficiency and power consumption. ***FY 2016 Plans:*** Validate and mature multifunction SWIR fiber-based laser breadboard, and components for performing functions such as: LRF, laser illumination, laser pointing, and LIDAR; investigate novel laser pulsing technologies to allow for compact and lightweight, solid state lasers at reduced cost; design 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 Mid Wave Infrared (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, 3-dimensional 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.	5.178	5.276	4.746
Title: Advanced Structures for Cooled Infrared (IR) Sensors	5.655	5.763	5.892

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 the reliability by means of 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 2015 Accomplishments:*** Investigated new growth methods for improving the uniformity and reducing the cost of very LWIR (wavelength greater than 11 microns) III-V and II-VI materials; investigated new techniques for passivating LWIR III-V small pixel structures; mitigated effects of initial substrate condition and processing on resulting performance; designed and validated read-out circuits appropriate for these FPAs. ***FY 2016 Plans:*** Investigate 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; continue investigation of new techniques for etching and passivating LWIR III-V and II-VI small pixel structures; investigate 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.			
Title: Enhanced IR Detector ("nBn") Technology ***Description:*** This effort investigates and develops a new detector structure for the development of sensors with increased sensitivity. In "nBn" technology an electron-barrier (“B”) layer is placed between two negatively charged (n-type or “n”) conductive layers, to reduce flow of charge through the material. The reduction in charge flow reduces the noise intrinsic to the material, thus, increasing the material’s sensitivity. The objective of the effort is to make MWIR FPAs easier and more affordable to manufacture and to enable operation at higher temperatures, resulting in more affordable sensor systems with significant reductions in SWaP of system optics, housings and cryogenic coolers. In addition, the barrier detector approach allows for very small pixel pitch (8 micron) enabling FPAs of very large format, 5000x5000 pixel, for persistent surveillance applications that were not possible prior to emergence of this barrier FPA technology.	3.720	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
FY 2015 Accomplishments: Researched and developed nBn large format FPAs (up to 3000x3000, 8-micron pitch) with a cutoff wavelength at or greater than 5 microns and operating at temperatures at or exceeding 130 Kelvin with a goal to achieve repeated performance comparable to indium antimonide; developed processing and hybridization for 8 micron pixel FPAs.			
Title: Strained Layer Superlattices (SLS) Technology ***Description:*** This effort investigates and improves III-V material (materials formed by a combination of elements from Groups III and V of the periodic table) thin film crystal growth of IR FPAs using a very flexible SLS structure. This will allow high performance multi band infrared FPAs to be produced at much lower costs than the existing II-VI FPAs (Mercury Cadmium Telluride) and can leverage commercial product research and production lines, including cell phone chips, to improve uniformity related to performance. ***FY 2015 Accomplishments:*** Verified fabrication techniques for a 1280x720, 12 micron pitch, dual-band MWIR/LWIR FPA on analog Readout Integrated Circuits (ROICs) with increased quantum efficiency and reduced noise equivalent differential temperature; hybridize 16 bit digital ROIC with characterized 640x480, 20 micron pitch LWIR FPA; extended cutoff wavelength device designs to 11.5 and 13.5 microns.	4.141	-	-
Title: Wide Field of View Displays and Processing for Head Mounted Display Systems ***Description:*** This effort investigates and designs optical filters, objective lenses and personal display viewing optics that will enable ultra-low profile, lightweight sensors and virtual displays for both individual head mounted and vehicle based, multi-user vision systems using the latest developments in holograms for small package optics that can be readily reconfigured (i.e., ultra-small/light optical zoom). Additional work in this effort investigates image processing as part of the optical design strategy and designs novel approaches for color filtering image processing for low light sensors in order to provide a color low-light imaging capability to the Warfighter. This effort is fully coordinated with PE 0603710A. ***FY 2015 Accomplishments:*** Integrated waveguide optical components into head wearable form factors for limited data collections and Soldier perception testing; validated ability of large area waveguide virtual displays to provide the space stabilized display in scenes with jitter; fabricated and integrated color low light solid state silicon focal plane as a test platform; determined optimum color filter array spectral requirements; improved patterned interference filter coating technology for sub-10 micron pixel spacing; conducted experiments on tactical target low light color phenomenology.	5.803	-	-
Title: Solid State Low Light Imaging	4.782	4.971	-

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 Digital Read-Out Integrated Circuit (DROIC) technology. ***FY 2015 Accomplishments:*** Optimized pixel size and developed back-side illuminated silicon processes for near IR resolution comparable to current I2 technology; developed through silicon via processing capability for 3D stacking of small pixel silicon FPAs; investigated back-end processing techniques for stacking FPAs with electronics and displays; conducted design studies to determine image processing techniques required for low latency night imaging. ***FY 2016 Plans:*** Leverage C-MOS and 3D DROIC design to achieve high resolution, low latency, stacked, lowlight silicon sensor and micro-display imaging components; validate design by conducting experiments of stacked wafer fabrication runs with C-MOS pixel densities equivalent to the full resolution designs; investigate and design low profile folded and switchable optics compatible with objective lens and eye piece lens functions suitable for the solid state stacked imager design.			
Title: Sensing and Processing ***Description:*** This effort investigates processing and sensor fusion technology for low cost multi-modal sensors. Processing and sensor fusion technology will enable the capability to see through Degraded Visual Environments (DVE) and to improve Situational Awareness (SA) through automated recognition of personnel and obstacles. ***FY 2015 Accomplishments:*** Investigated incorporation of algorithms for improved SA and mobility in DVE; developed low power processing techniques for improved imaging through DVE.	2.022	-	-
Title: Three-Dimensional (3D) Micro-Electronics for Night Vision Sensors ***Description:*** The goal of this effort is to investigate new 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 Plans:***	-	5.913	5.836

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Investigate new lens designs to include radially indexed materials for enhanced beam steering, metamaterials, and improved coatings for improved transmission/reflectivity. Microdisplay 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 FY16 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.			
Title: Multi-Function Digital Readout Integrated Circuits (DROICs) for Cooled and Uncooled Focal Plane Arrays (FPAs) ***Description:*** The objective of this effort is the development of advanced Two-Dimensional (2D) and 3D DROICs to replace legacy 2D analog ROICs. This effort will investigate and design a digital readout architecture optimized for large format, high resolution, high IR FPAs through the use of modeling, analysis, and simulations. This enabling technology will bring substantial advancements to IR imaging capabilities. ***FY 2016 Plans:*** Investigate and develop novel Analog to Digital (A/D) architectures for new high definition FPAs; investigate A/D architectures compatible with 2D or 3D integration by use of advanced lithographic techniques; develop small pitch vertical interconnect 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.	-	4.868	6.645
Title: Computational Imaging ***Description:*** This effort develops component technology designed to reduce soldier workload, increased battlespace awareness, threat detection and target identification. The objective is to provide enhanced situational awareness with extended range and multi-spectral imaging capability, with reductions to the size, weight, and cost (SWaC), for the individual warfighter. This is accomplished through integrating computational imaging, novel optics and digital read out electronics. This effort will develop	-	-	5.228

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
a methodology of computation and optics combined with display and vision processing for improved target discrimination and visualization; improve mounted and dismounted soldier mobility 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.			
Accomplishments/Planned Programs Subtotals	38.194	33.807	36.079

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
K90: *NIGHT VISION COMPONENT TECHNOLOGY (CA)*	-	6.500	5.000	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 2015	FY 2016
Congressional Add: Program Increase	6.500	5.000
FY 2015 Accomplishments: Program increase for night vision technology research. Developed Future Vertical Lift camera brassboard with high sensitivity, high dynamic range, and high resolution necessary to see through all degraded visual environments, with fast framerates for hostile fire indication; developed digital low light camera sensor arrays for insertion into brassboard cameras for user test and evaluation; integrated short-wave infrared sensor arrays with new read-out integrated circuit technology for insertion into a camera and subsequent integration into a crew-served weapon sight brassboard to validate an integrated day/night pointing and handoff capability; developed conceptual models for both sector and 360˚ collection modes that when used with the detection and tracking algorithms will inform Armor and Fires combat developers of capabilities and support needs (i.e. network bandwidth) in their air-defense requirement generation process. ***FY 2016 Plans:*** This is a Congressional Interest Item.		
Congressional Adds Subtotals	6.500	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: PB 2017 Army	Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	28.597	36.568	26.497	-	26.497	26.663	26.996	27.531	28.067	-	-
H24: *Countermine Tech*	-	20.239	19.445	20.821	-	20.821	20.930	21.238	21.658	22.077	-	-
H35: *Camouflage & Counter-Recon Tech*	-	4.858	5.623	5.676	-	5.676	5.733	5.758	5.873	5.990	-	-
HB2: *COUNTERMINE COMPONENT TECHNOLOGY (CA)*	-	3.500	11.500	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 countermine/counter improvised explosive device, signature management and counter-sensor capabilities. Focus areas are sensor components, sub-components and software algorithms to improve detection of mines, explosive threats and 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 Countermine technologies to accurately detect 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 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 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: PB 2017 Army	**Date:** February 2016
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602712A / *Countermine Systems*

B. Program Change Summary ($ in Millions)	**FY 2015**	**FY 2016**	**FY 2017 Base**	**FY 2017 OCO**	**FY 2017 Total**
Previous President's Budget	29.428	25.068	26.497	-	26.497
Current President's Budget	28.597	36.568	26.497	-	26.497
Total Adjustments	-0.831	11.500	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	11.500			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.831	-			

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2015**	**FY 2016**
Project: HB2: *COUNTERMINE COMPONENT TECHNOLOGY (CA)*		
Congressional Add: *Program Increase*	3.500	4.000
Congressional Add: *Explosives Detection Technology*	-	7.500
Congressional Add Subtotals for Project: HB2	3.500	11.500
Congressional Add Totals for all Projects	3.500	11.500

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H24: *Countermine Tech*	-	20.239	19.445	20.821	-	20.821	20.930	21.238	21.658	22.077	-	-

A. Mission Description and Budget Item Justification

This project investigates, designs and evaluates new countermine 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.

This project supports Army science and technology efforts in the Ground Maneuver, Command, Control, Communications and Intelligence, Air and Soldier 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 Communications-Electronics Research, Development and Engineering Center (CERDEC)/Night Vision and Electronic Sensors Directorate, Fort Belvoir, VA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Title: Standoff Sensors for Explosive Hazard Detection	5.054	9.961	10.511
Description: This effort addresses the challenges of sensing and confirming potential in-road and/or 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 and shallow buried targets. This effort also investigates new sensor technologies, to confirm buried threats at deeper depths.			
FY 2015 Accomplishments: Integrated dual band FL GPR and EO/IR sensors on a brassboard demonstrator; conducted phenomenology studies to determine feasibility of fusion of multiple sensor modalities for improved detection; extended detection depth of low parity Doppler interferometer using seismic sources.			
FY 2016 Plans: Validate dual band FL GPR components using new phased arrays; explore polarization phenomenologies with Short Wave Infrared (SWIR) through Long Wave Infrared (LWIR) waveband sensors to discriminate man-made objects; investigate vibration sensors to distinguish targets from clutter; explore ground profiling sensors (Light Detection and Ranging (LIDAR), X-band radar)			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
to improve FL GPR data by removing surface clutter; study 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 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.			
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 PE 0602622A/Project 552. ***FY 2015 Accomplishments:*** Improved algorithms and signal processing to maximize discrimination and reduce false alarms of explosive components; conducted data collections in various conditions to determine detection and identify capabilities against explosive compounds, using quantum dots for close proximity sensing and Quantum Cascade Lasers (QCLs) for stand-off trace detection. ***FY 2016 Plans:*** Analyze data collected in various conditions, and optimize sensitivity and spectral selectivity of new polymer-based quantum dot sensors using remote and hand held excitation sources; investigate new technologies to extract surface vapor signals.	4.509	2.858	-
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 2015 Accomplishments:*** Conducted laboratory data collections using GPR, wide bandwidth metal detectors, and position measurement sensors mounted in a handheld emulation platform to establish a correlated dataset; conducted experiments to determine highly accurate sensor	5.495	3.626	7.500

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
position to improve display of sweep location and subsurface threats; developed near real-time detection and processing capability; conducted trade studies to determine the best combination of novel components and sensors for real-time detection and identification of buried explosive hazard threats using Nuclear Quadrupole Resonance (NQR), GPR and frequency domain metal detectors. ***FY 2016 Plans:*** Conduct 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 NQR, GPR, and frequency domain metal detectors; explore advanced signal processing approaches using correlated data from various modalities and determine optimal data processing and algorithm techniques; utilize outcome of optimal datasets as feedback to sensor redesigns and experimentation; determine highly accurate sensor position to improve feedback to reduce the operator's cognitive burden and improve clutter rejection. ***FY 2017 Plans:*** 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.			
Title: Explosive Hazard Neutralization Technologies ***Description:*** This effort investigates emerging neutralization technologies and techniques to address Warfighter needs to effectively neutralize explosive hazards (to include HMEs). ***FY 2015 Accomplishments:*** Investigated fiber laser based techniques for low or high-order neutralization of explosive threats at standoff ranges.	1.181	-	-
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 2015 Accomplishments:***	4.000	3.000	2.810

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Instigated a series of knowledge capture events with industry and academia; developed novel and innovative research efforts in counter-IED detection; began analysis of research areas focusing on non-traditional approaches (such as crowd sourcing and novel sensors) identified as having high potential for significant breakthroughs. ***FY 2016 Plans:*** Continue the series of knowledge capture events with industry and academia; focus efforts on characterizing counter-IED detection phenomenology; continue analysis and begin 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 FY15 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).			
Accomplishments/Planned Programs Subtotals	20.239	19.445	20.821

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H35: *Camouflage & Counter-Recon Tech*	-	4.858	5.623	5.676	-	5.676	5.733	5.758	5.873	5.990	-	-

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 develop 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.

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 and the Army Modernization Strategy.

Work in this project is performed by the 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 2015	FY 2016	FY 2017
Title: Camouflage and Counter-Reconnaissance Technology for Advanced Spectral Sensors	4.858	5.623	5.676
Description: This effort investigates and advances new techniques to reduce susceptibility of sensors and camouflage 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 due to incoming energy from lasers as well as EO and IR sensor systems.			
FY 2015 Accomplishments: Investigated uncooled Focal Plane Array (FPA) vulnerabilities and exploitation against multiple laser threats; conducted initial studies into adaptive protection for Long Wave Infrared (LWIR) sensors; incorporated large format array sensor protection solution into hardware/software demonstrators; evaluated multispectral camouflage to include thermal signature reduction technology.			
FY 2016 Plans: Study uncooled FPA resiliency against laser threats; investigate uncooled FPA protection including Micro-electromechanical Systems (MEMS) devices and tunable IR filters; investigate best approach to harden Day-TV cameras against laser threats; investigate methods of laser protection for high performance cooled IR sensors, including linear and non-linear optical			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
approaches. Explore spectral response of next generation lightweight camouflage net systems, as well as different methods to imbed a thermal pattern into the net systems; optimize 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 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.			
Accomplishments/Planned Programs Subtotals	4.858	5.623	5.676

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
HB2: *COUNTERMINE COMPONENT TECHNOLOGY (CA)*	-	3.500	11.500	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 2015	FY 2016
Congressional Add: Program Increase ***FY 2015 Accomplishments:*** Conducted research on improved vehicular mounted forward looking anomaly sensing, which aids operators by visually scanning forward to cue potential buried or concealed tactical and unexploded ordnance (UXO) threats, in-road and roadside; and the confirmation of explosive threats, including UXO, using handheld and/or robotic sensors, which utilizes a combination of sensor inputs to increase capability. ***FY 2016 Plans:*** This is a Congressional Interest Item	3.500	4.000
Congressional Add: Explosives Detection Technology ***FY 2016 Plans:*** This is a Congressional Interest Item	-	7.500
Congressional Adds Subtotals	3.500	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: PB 2017 Army	Date: February 2016
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*

COST ($ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	23.434	23.681	23.671	-	23.671	24.034	24.636	25.094	25.596	-	-
H70: *Human Fact Eng Sys Dev*	-	23.434	23.681	23.671	-	23.671	24.034	24.636	25.094	25.596	-	-

A. Mission Description and Budget Item Justification

This Program Element (PE) conducts applied research on aspects of human factors engineering that impact the capabilities of individual and teams of Soldiers operating in complex, dynamic environments. The results of the research will enable maximizing the effectiveness of Soldiers and their equipment for mission success. The aspects of human factors that will be studied include sensing, perceptual and cognitive processes, ergonomics, biomechanics and the tools and methodologies required to manage interaction within these areas and within the Soldiers' combat environment. Project H70 research is focused on decision-making; human robotic interaction; crew station design; improving Soldier performance under stressful conditions such as time pressure, information overload, information uncertainty, fatigue, on-the-move and geographic dispersion; and enhancing human performance modeling tools.

Work in this project leverages basic research performed in PE 0601102A (Defense Research Sciences), and complements and is fully coordinated with PE 0602601A (Combat Vehicle and Automotive Advanced Technology), PE 0602786A (Warfighter Technology), PE 0602120A (Sensors and Electronic Survivability), PE 0602784A (Military Engineering Technology), PE 0602783A (Computer and Software Technology), PE 0602308A (Advanced Concepts and Simulation), PE 0602785 (Manpower/ Personnel/Training Technology), PE 0603005A (Combat Vehicle and Automotive Technology), PE 0603710A (Night Vision Advanced Technology), PE 0603015A (Next Generation Training and Simulation), and PE 0603007A (Manpower, Personnel, and Training Advanced Technology).

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

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

B. Program Change Summary ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Previous President's Budget	23.778	23.681	23.671	-	23.671
Current President's Budget	23.434	23.681	23.671	-	23.671
Total Adjustments	-0.344	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.344	-			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H70: *Human Fact Eng Sys Dev*	-	23.434	23.681	23.671	-	23.671	24.034	24.636	25.094	25.596	-	-

A. Mission Description and Budget Item Justification

This project conducts applied research on human factors to maximize the effectiveness of Soldiers in concert with their equipment. The resulting data are the basis for weapon systems and equipment design standards, guidelines, handbooks, and Soldier training as well as manpower requirements to improve equipment operation and maintenance. Application of this research will yield reduced workload, fewer errors, enhanced Soldier protection, user acceptance, and allows the Soldier to extract the maximum performance from the equipment.

Major efforts research sources of stress, potential stress moderators, and intervention methods, and identify and quantify human performance measures and methods to address current and future warrior performance issues. Individual efforts exploit adaptive learning methods and strategies, enhance and validate human performance modeling tools; investigate integration of advanced concepts in crew stations designs, optimizes interfaces for information systems and improves human robot interaction (HRI) in a full mission context.

Efforts in this program element 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.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Title: Interfaces for Collaboration and Decision Making	3.307	2.711	2.699
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 2015 Accomplishments: Examined communication capabilities of small team operations at the "edge" of the battlefield, with a focus on the effectiveness of different types of interfaces and (information) presentation techniques; and enhanced experimental platforms for studying mission			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
command network operations in civil-military scenarios. Goals were to develop techniques for improved information sharing, more effective use of available information, and new and enhanced metrics and methods that led to a better understanding of how human-network interactions impact distributed team performance. Research was conducted via human-system information flow modeling, lab, simulation, and field experimentation using novel information and collaboration technologies in realistic networked environments with teams ranging from squads to command headquarters sizes. ***FY 2016 Plans:*** Identify and investigate aspects of information displays and interfaces that best support the effective conduct of tactical intelligence; Validate the effectiveness of interface type and information presentation techniques in experimental decision aids such as the Warfighter Associate; and conduct 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.			
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 2015 Accomplishments:*** Developed HSI tools and methodologies to quantify the usability of systems developed to support team environments. These tools provided quantitative data that can be used to support acquisition and design trade off decisions. Research was conducted using findings from human sciences, algorithm development, field trials with military use cases, and feedback from the research, military, analyst, and system design and development communities. ***FY 2016 Plans:*** Enhance 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; expand 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; investigate the importance of coping style and working memory	3.465	2.672	1.128

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
capacity for improved prediction of cognitive performance while driving; and investigate 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:*** 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.			
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 2015 Accomplishments:*** Developed and matured brain-computer interaction technology for image analysis that is capable of adapting to the user for increased joint Soldier-system performance. ***FY 2016 Plans:*** Investigate novel approaches for image analysis that fuse computer vision and brain-computer interaction technologies for enhanced target identification 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.	2.242	3.338	2.288
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 2015 Accomplishments:*** Expanded applied research and analysis on the effects of physical and cognitive loads on Soldier performance to more operationally relevant environments; determined and matured guidelines for equipment developers and the Research and Development Centers that will lighten the Soldier physical, sensory, and cognitive burden and enhance Soldier and small team performance; applied techniques developed for quantifying the effects of weapon recoil on shooter performance to a broader area	6.257	6.204	7.507

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
of research (such as the effects of small arms equipment on marksmanship performance); and transitioned results to the U.S. Army Marksmanship Unit. ***FY 2016 Plans:*** Investigate effects of cognitive stress on physical performance; develop 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; conduct research to inform guidelines for equipment developers and the Research and Development Centers that will enhance Soldier and small team performance; investigate the effects of small arms recoil on shooter performance and transition results to research and development centers and the 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.			
Title: Human-Robot Interaction (HRI) ***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 2015 Accomplishments:*** Continued to focus on human-robot interaction by examining such issues as Soldier-robot interaction modes, communication, situation awareness, trust, and transparency in coordination with the ARL Autonomous Systems Enterprise partners. ***FY 2016 Plans:*** Develop 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 investigate 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.	4.173	3.164	2.998
Title: Understanding Socio-cultural Influence	1.990	2.019	2.029

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 2015 Accomplishments:*** Validated cognitive framework and proof of concept decision support tools; developed guiding principles for the presentation of socio-cultural information using validated cognitive framework; initiated extension of cognitive framework to encompass societal-level perspective leveraging historical Office of the Secretary of Defense (OSD)-investments; and determined experiment requirements for validation of extension. ***FY 2016 Plans:*** Conduct experiments on the effectiveness of information presentation using the socio-culturally informed design principles; integrate cognitive framework into select experimental decision support and training tools and validate 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.			
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:*** Will develop techniques to integrate behavioral, physiological, environmental, and task-based sensors to enable continuous low resolution multi-faceted monitoring of an individual.	-	-	1.600
Title: Soldier Sensory Performance	-	1.473	1.485

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 Plans:*** Conduct Soldier-centric research on personnel-borne improvised explosive device (IED) detection technologies to characterize operator/system strengths and constraints, and maximizing IED detection performance; conduct 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; continue 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; conduct a study to examine the efficacy of two-way tactile communication to support squad-level communications; explore 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.			
Title: Training Effectiveness Research ***Description:*** Novel technologies and their implementation in Army systems may result in demands on Soldiers that exceed their knowledge, skill, or memory capacity. When demands cannot be remediated by human systems integration, training may enable the demands to be met. This effort will identify human operator tasks in complex, intelligent, and emerging systems critical to mission employment of new technologies. The aspects (particularly knowledge and skill) of those tasks will be determined through experimentation and analysis to inform development of training and simulation technologies, fundamental research on the effectiveness of training regimes, and simultaneous task combinations that must be trained. 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 2015 Accomplishments:***	1.000	1.000	0.937

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Investigated emerging technologies and targeted those likely to place significant demands on human operators, in particular intelligent, decision-aiding, and autonomous systems for which transparency and trust are crucial; conducted analyses of two emerging or projected technologies in the context of mission performance to determine combinations of tasks, such as, those resulting from use of the emerging technology and those from legacy systems, those requiring understanding of dynamic system models, required for mission performance; and conducted research on task combinations to determine parameters that may inform the development of training technologies. ***FY 2016 Plans:*** Identify user skills that are critical to interacting with intelligent, autonomous systems and appropriate methods for measuring the user's skill level; and identify or mature 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.			
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 and performance (MOEs and 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 2015 Accomplishments:*** Conducted research to identify relative contributions and interactions of factors critical to Soldier and team system performance; worked within Human Systems community to identify and prioritize critical human performance MOEs and MOPs; conducted research to support development of high priority measures not supported by sufficient empirical data involving interaction among factors such as mission demands, environment, human characteristics, equipment and technology; and proposed modifications to individual measures to account for small team performance. ***FY 2016 Plans:***	1.000	1.100	1.000

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Develop 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 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.			
Accomplishments/Planned Programs Subtotals	23.434	23.681	23.671

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: PB 2017 Army	Date: February 2016
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*

COST ($ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	15.288	20.850	22.151	-	22.151	22.640	22.765	23.141	23.603	-	-
048: *Ind Oper Poll Ctrl Tec*	-	1.567	2.341	2.718	-	2.718	2.848	2.886	2.949	3.008	-	-
835: *Mil Med Environ Crit*	-	5.273	7.017	7.803	-	7.803	8.003	8.040	8.196	8.360	-	-
895: *Pollution Prevention*	-	0.000	3.475	3.474	-	3.474	3.474	3.474	3.474	3.543	-	-
896: *Base Fac Environ Qual*	-	8.448	8.017	8.156	-	8.156	8.315	8.365	8.522	8.692	-	-

Note

Not applicable for this item

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 in 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: PB 2017 Army	Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Previous President's Budget	15.653	20.850	22.151	-	22.151
Current President's Budget	15.288	20.850	22.151	-	22.151
Total Adjustments	-0.365	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.365	-			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
048: *Ind Oper Poll Ctrl Tec*	-	1.567	2.341	2.718	-	2.718	2.848	2.886	2.949	3.008	-	-

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 possesses 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 (formerly Enduring Technologies) 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 2015	FY 2016	FY 2017
Title: Sustainable Ranges and Lands	1.567	1.401	1.763
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 2015 Accomplishments: Investigated technologies/methods for national, regional, and installation Threatened and Endangered Species (TES) management strategies to enable fielding of materiel systems, minimize adverse training and testing impacts, and reduce compliance costs associated with currently listed and anticipated increases in federally listed species.			
FY 2016 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Develop a training land conflict analysis framework that accounts for current and future live training requirements and Threatened and Endangered Species distributions to assess impacts of proposed species listings on training land requirements; investigate innovative techniques for assisted species movement to minimize potential training impacts to Army lands; explore 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.			
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 Plans:*** Develop and evaluate 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.	-	0.940	0.955
Accomplishments/Planned Programs Subtotals	1.567	2.341	2.718

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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*

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
835: *Mil Med Environ Crit*	-	5.273	7.017	7.803	-	7.803	8.003	8.040	8.196	8.360	-	-

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 projects 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 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 Innovation Enablers (formerly Enduring Technologies) 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 2015	FY 2016	FY 2017
Title: Life Cycle of Military Materials in the Environment	3.218	4.346	3.460
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 2015 Accomplishments:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Developed tools to provide near real-time data for identification and semi-quantification of environmental chemical hazards to support life cycle analysis, expeditionary operations, and computational tools to predict potential environmental hazards of existing and emerging munitions and pyrotechnics. ***FY 2016 Plans:*** Devise 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; develop software tools 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.			
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 the environment. ***FY 2015 Accomplishments:*** Developed methodologies to evaluate Army-unique materials comprised of nanomaterials for environmental health and safety impacts throughout their lifecycle. These methodologies are needed to make risk informed decisions and enable rapid fielding of advanced nanomaterial based products. ***FY 2016 Plans:*** Devise 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; develop 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.	2.055	2.671	3.013
Title: Advanced Remediation Technologies	-	-	1.330

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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:*** 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.			
Accomplishments/Planned Programs Subtotals	5.273	7.017	7.803

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
895: *Pollution Prevention*	-	0.000	3.475	3.474	-	3.474	3.474	3.474	3.474	3.543	-	-

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.

Work in this project supports the Army Science and Technology Innovation Enablers (formerly Enduring Technologies) 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.

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 2015	FY 2016	FY 2017
Title: Pollution Prevention Technologies	-	3.475	3.474
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 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Conventional Ammunition: Develop precision loading processes for novel lead-free primer formulations; Rocket and Missile Propellants: Conduct static motor testing of novel lead-free burn rate modifiers in minimum signature applications; Toxic Metal Reduction: Develop and refine portable hexavalent chromium-free process for generating wear resistant surface coatings. ***FY 2017 Plans:*** 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.			
Accomplishments/Planned Programs Subtotals	-	3.475	3.474

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
896: *Base Fac Environ Qual*	-	8.448	8.017	8.156	-	8.156	8.315	8.365	8.522	8.692	-	-

A. Mission Description and Budget Item Justification

This project designs and develops tools and 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 missions. This project provides the Army 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 how the use of those resources effect mission support and environmental compliance. The project investigates, designs, and develops novel methods and 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 Innovation Enablers (formerly Enduring Technologies) 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 2015	FY 2016	FY 2017
Title: Sustainable Ranges and Lands	4.464	3.927	4.056
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 2015 Accomplishments: Investigated new analytical methods for incorporating the direct impacts of climate change, and related dynamic processes such as urban encroachment, into Army enterprise long-term planning processes that enable Army transformation and materiel fielding; developed advanced decision metrics that quantify climate uncertainty on mission-relevant built and natural infrastructure			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
and processes in a manner that is consistent with current Army plans and planning processes; investigated the underlying fundamental physical and ecological processes of these advanced decision metrics and their response to projected climate change. Initiated development of next generation real-time noise management technologies to provide the ability to adaptively manage and reduce noise impacts to live training for installations experiencing existing and emerging encroachment impacts on training lands. ***FY 2016 Plans:*** Develop capabilities that incorporate direct and indirect impacts of climate change and related trending dynamic conditions into critical Army enterprise decisions; provide a tiered approach to climate change impact assessments that scale from local to national scale applications. Extend climate change assessment analyses to include maneuver area capacity, live-fire range capacity, and facility operations and maintenance costs. Develop 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. Develop 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.			
Title: Military Materials in the Environment ***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 2015 Accomplishments:*** Designed tools for detecting and modeling the source of emerging threat agents in areas of denied access. This capability identifies and predicts fate of unique contaminant threats and provides information about the quality and spatial distribution of water sources at a landscape scale within an operational area. Began the development of tools to predict soil characteristics and	3.984	4.090	4.100

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
contaminant behavior in soil using remote sensing and sparse data extrapolation techniques in areas of limited access to improve initial entry operations and expeditionary force movement and maneuver. ***FY 2016 Plans:*** Utilizing a multidisciplinary approach (geochemical, geographical, soil science, and computational chemistry) develop an understanding of soils and contaminants in austere environments; apply sophisticated genetic algorithms to develop empirical, 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 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.			
Accomplishments/Planned Programs Subtotals	8.448	8.017	8.156

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: PB 2017 Army	Date: February 2016
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*

COST ($ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	33.117	36.160	37.803	-	37.803	39.092	38.489	39.257	40.053	-	-
779: *Command, Control And Platform Electronics Tech*	-	14.407	15.805	16.444	-	16.444	17.863	17.482	17.826	18.183	-	-
H92: *Communications Technology*	-	18.710	20.355	21.359	-	21.359	21.229	21.007	21.431	21.870	-	-

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; and allows timely distribution, presentation/display and use of MC data on Army platforms. 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 is complementary of PE 0601104A (University and Industry Research Centers), PE 0602270A (Electronic Warfare Technology) , PE 0602705A (Electronics and Electronic Devices), PE 0603008A (Electronic Warfare Advanced Technology), 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 fully 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: PB 2017 Army	Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Previous President's Budget	33.807	36.160	38.461	-	38.461
Current President's Budget	33.117	36.160	37.803	-	37.803
Total Adjustments	-0.690	0.000	-0.658	-	-0.658
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.690	-			
• Adjustments to Budget Years	-	-	-0.658	-	-0.658

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
779: *Command, Control And Platform Electronics Tech*	-	14.407	15.805	16.444	-	16.444	17.863	17.482	17.826	18.183	-	-

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: in the command post, in vehicles, or dismounted. 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/data to decisions; 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.

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 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 2015	FY 2016	FY 2017
Title: Assured Positioning, Navigation, and Timing (A-PNT)	4.677	3.870	5.690
Description: This effort investigates positioning, navigation and timing 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 PE 0603772A/project 101 complements this effort. ***FY 2015 Accomplishments:*** Investigated and analyzed new sensor technologies for potential navigation and timing applications such as atomic sensors, multi-Global Navigation Satellite Systems (multi-GNSS), emerging signals of opportunity (SOOs), and micro-electromechanical systems (MEMS) focusing on improvements to individual sensors and methods for improved manufacturing techniques allowing the potential for smaller integrated navigation systems; examined vision based sensors and other aiding techniques such as human motion classification and network assisted navigation to enable navigation in the absence of GPS signals; investigated			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
GPS augmentation systems to evaluate compatibility with new Military-Code (M-Code) receiver chips and the ability to make GPS user equipment for ground vehicles and dismounted Soldiers less susceptible to interference sources. ***FY 2016 Plans:*** Investigate MEMS sensors, anti-jam/anti-spoof antennas, multi-GNSS receivers that incorporate M-code capability; research the application of laser-based light detecting and ranging (LIDAR) as an improvement over visible light vision systems; investigate a common interface for PNT applications to enable the seamless incorporation of new sensors; research the application of atomic sensors for gyros, accelerometers and clocks for independent location information using no external signals; explore the feasibility of integrating star trackers with terrestrial PNT systems; research performance effects on navigation solutions when incorporating a variety of emerging PNT technologies such as cameras with rolling vs. global shutters; mature Blue Force Electronic Attack (BFEA) models and simulations to emulate and account for M-code enabled GPS receivers; conduct 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 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.			
Title: Next Generation Mission Command (MC) 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 and increases the situational awareness and decision making capacity across the battlefield. Work being accomplished under PE 0603772A/project 101 complements this effort. ***FY 2015 Accomplishments:***	9.730	11.935	10.754

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Researched and brassboarded the required data, system architectures, and leader tools needed to provide continuously available MC capabilities from tactical through strategic echelons; investigated and designed multi-echelon, unified MC software with a particular emphasis on enabling small unit commander-centric operations; designed and coded MC software that dynamically assesses the mission and the battle space to help maximize mission success by managing limited and distributed resources,; designed and coded software tools that enable Soldiers to explore data, visualize relationships, and create and modify workflows to update and modify MC software applications without re-programming and revalidation; designed MC software that analyzes unstructured and structured data from discourse, social media, and computer systems to provide alerts, suggest collaboration opportunities, and deliver expert level decision support to the commander; designed and coded software that measures individual and staff workload to facilitate more agile team operation and that applies distributed computing to solve a complex, multi-element problem within a small group of Soldiers without reach back to higher echelons. ***FY 2016 Plans:*** Design and validate 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; investigate a virtual staff capability to supply staff-like functionality to the commander; mature 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; investigate 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; design 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.			
Accomplishments/Planned Programs Subtotals	14.407	15.805	16.444

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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*

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H92: *Communications Technology*	-	18.710	20.355	21.359	-	21.359	21.229	21.007	21.431	21.870	-	-

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 focuses development in wireless transport (e.g. mobile radio based communications systems) to develop 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 enabling antenna components, materials, designs and configurations to reduce the visual signature of antennas on Soldier, vehicular and airborne platforms and reduce co-site interference on platforms with multiple transceivers such as radios and jammers. Additionally this project investigates 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 network operations software and techniques that improve the ability of the Soldier to manage and maintain complex, dynamic networks; and improved spectrum management software tools to make more efficient use of over-subscribed RF spectrum. This project also provides new technology capabilities to lower the size, weight, power (SWaP) and cost of networking systems deployed on Army platforms through rapid technology improvements in hardware and software convergence.

This project supports Army science and technology efforts in the Command, Control, Communications (comms) and Intelligence 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 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 2015	FY 2016	FY 2017
Title: Antenna and Hardware Technologies	3.871	2.787	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 further 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. This effort also provides new technology capabilities to lower the SWAP and cost of networking systems deployed on			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Army platforms through hardware and software convergence. Work being accomplished under PE 0602270A/project 906, PE 0603008A/project TR1, PE 0603270A/project K15 and PE 0603794A/project EL4 complements this effort. ***FY 2015 Accomplishments:*** Designed and matured a smart switching system for distributed antenna arrays enabling higher output power, interoperability and improved link connectivity for SATCOM; investigated and matured antenna systems and arrays that provide improved communications performance and reliability through EW jammed environments; developed and finalized a government standard architecture to provide standard form-fit and electronic interfaces for distributed terrestrial and SATCOM antenna systems to support interchange of communications modes on battlefield platforms. ***FY 2016 Plans:*** Complete and demonstrate in a lab environment a smart switch for distributed antenna arrays enabling higher output power, interoperability and improved link connectivity for SATCOM; complete and demonstrate in a lab environment antennas and antenna arrays that provide improved communications performance and reliability through EW jammed environments; design/ develop 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: Tactical Information Assurance (IA) and Cyber Defense ***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 under PE 0603008A/project TR2 and 0603794A/ project EL5 complements this effort, and is fully coordinated with the Army Research Lab Cyber Security Collaborative Research Alliance, PE 0601104A/ project EA6. ***FY 2015 Accomplishments:*** Evaluated and matured optimized cyber maneuver capabilities that incorporate the use of reasoning, intuition, and perception while determining the optimal scenario on when to change network configurations and settings to increase the difficulty for red forces to perform malicious network reconnaissance prior to attack; encoded, evaluated and matured software to provide a	9.114	8.654	7.180

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
feedback system to optimize the effectiveness of cyber maneuver and threat assessments; researched algorithms and evaluated the effectiveness of dynamically maneuvering computer operating systems and applications to further restrict red force ability to perform malicious reconnaissance on tactical network components and hosts; matured and optimized data sharing and collaboration techniques between offensive and defensive operations and across security boundaries to enable advanced warning and response actions; researched trans-disciplinary computer experimentation models that emulate attackers-defenders-users interactions and associated technological and human interrelationships; researched a software based encryptor point solution that meets National Security Agency (NSA) formal requirements to eliminate the need for physical encryption devices on Army tactical communications systems.			
FY 2016 Plans: Design and code 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; design and code a software based encryptor that meets NSA formal requirements to eliminate the need for physical encryption devices; mature design of security for network protocols; research, design and develop algorithms to identify, protect, and prevent insider threat negligence and-or malicious actions; research and design 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; research, design and code software that incorporates cyber risk assessment, threat detection, cyber response agility and psycho-social behavior prediction to improve network security; design and develop 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 is 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 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			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 PE 0603008A/project TR2 and 0603794A/ project EL5 complements this effort. ***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: 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 such as scintillation. Work being accomplished under PE 0603008A/project TR1 and 0603794A/ project EL4 complements this effort. ***FY 2015 Accomplishments:*** Investigated techniques for managing and self-initiating wireless networks to improve robustness, efficiency and capacity; investigated coordinated scheduling algorithms and efficient architectures, routing protocols etc. and incorporated a range of techniques (including directional networking, multi function waveforms, interference mitigation etc. to achieve efficient spectrum use and enable tactical wireless networks to increase overall performance in hostile and RF environments including spectrum congested and GPS denied environments; researched network and physical layer models for tactical networking waveforms to enable the evaluation of the effectiveness of new signal processing and networking technologies to overcome RF interference such as red force jamming; designed and coded network reasoning software to enable the dynamic selection of signal processing and RF transmission techniques such as adaptive signal cancellation, coordinated scheduling of discontiguous signals, directional networking and multiple input multiple output networks to overcome adversarial RF jamming; developed a waveform architecture	5.725	8.914	6.888

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
to define interfaces between the various RF, networking and signal processing hardware components; evaluated and developed signal analysis algorithms to detect RF interference of SATCOM signals; researched and performed system analysis for protected SATCOM architectures to support modulation, coding and redundancy protection methods; researched and analyzed precision polarization concepts to support multiple communications paths and bandwidth expansion; performed modeling, simulation and emulation of networks to assess performance in contested environments; matured and evaluated performance of a signals management module for integration into the Soldier Radio Waveform to manage communications and blue force jamming RF emissions to prevent cosite interference while maintaining communications/jamming performance.			
FY 2016 Plans: Continue to develop and mature network and physical layer models for tactical networking waveforms to overcome RF interference; develop digital signal processing and adaptive interference cancellation algorithms to enable efficient utilization of spectrum; investigate and mature a waveform architecture to define interfaces between the various RF, networking and signal processing components; develop directional networking and disruption tolerant networks to protect the network from electronic warfare systems while using spectrum efficiently; continue 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; develop network protocols for operations in contested electromagnetic environment using techniques such as interference cancellation, multifunction waveform and coordinated scheduling algorithms for electronic protection optimization; develop software defined networks for tactical applications; mature and begin implementation of feasible architectures and technologies for increasing tactical network capacity and performance in a dynamic spectrum environment; develop the framework for an adaptive media access code physical layer to evolve the tactical network while improving capacity; develop resilient core and routing protocols to increase performance of the tactical network; begin development of protocols to support mission and user-aware routing and content based networking; begin development of networking frameworks and network abstraction layer for interoperable end to end voice over internet protocol; research feasible approaches to enable networking in Global Positioning System denied environment; develop 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			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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 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.			
Accomplishments/Planned Programs Subtotals	18.710	20.355	21.359

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: PB 2017 Army	Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	10.514	12.656	13.811	-	13.811	14.007	14.136	14.415	14.703	-	-
Y10: *Computer/Info Sci Tech*	-	10.514	12.656	13.811	-	13.811	14.007	14.136	14.415	14.703	-	-

A. Mission Description and Budget Item Justification

This Program Element (PE) develops and evaluates hardware and software algorithms enabling enhanced understanding and accelerating the decision cycle time for commanders and leaders operating in a mobile, dispersed, highly networked environment. Project Y10 supports research on information and communications technology.

Work in this PE complements and is fully coordinated with efforts in PE 0602705A (Electronics and Electronic Devices), 0602716A (Human Factors Engineering Technology), PE 0602782A (Command, Control, Communications Technology), PE 0603772A (Advanced Tactical Computer Science and Sensor Technology), and PE 0603008A (Command, Control, Communications Advanced Technology).

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) at the Adelphi and Aberdeen Proving Ground, MD locations.

B. Program Change Summary ($ in Millions)	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Previous President's Budget	10.761	12.656	13.811	-	13.811
Current President's Budget	10.514	12.656	13.811	-	13.811
Total Adjustments	-0.247	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.247	-			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Y10: *Computer/Info Sci Tech*	-	10.514	12.656	13.811	-	13.811	14.007	14.136	14.415	14.703	-	-

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 2015	FY 2016	FY 2017
Title: Information Processing	1.248	1.696	1.833
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 2015 Accomplishments: Characterized techniques for predicting crowd attitudes, intent, and behaviors from fused text sources; and developed concepts for integrating social network analysis into Mission Command.			
FY 2016 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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:*** 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.			
Title: Information Assurance ***Description:*** This effort designs and characterizes software for the protection of information and networks in wireless tactical environments. The goal is to develop software algorithms that detect and defeat malicious activities of adversaries in bandwidth constrained tactical networks. ***FY 2015 Accomplishments:*** Designed and characterized an intrusion prevention architecture that dynamically monitors host and network data to detect, analyze, respond, and protect against unauthorized cyber activity in bandwidth- and power-constrained environments; investigated models that were used to develop and characterize secure protocols that may be used in tactical networks; and explored active protection approaches that may be managed and/or deployed locally, centrally, or in a distributed environment. ***FY 2016 Plans:*** Develop and characterize techniques for novel stealthy (i.e., low probability of detection and intercept) information communications for future tactical networks; develop computational tools that provide theoretically-grounded risk assessments and situational awareness by integrating a broad range of information about vulnerability and network structure and roles that is automatically obtained from the network; and design innovative detectors, analyst aids, and prevention/recovery tools that provide robustness and fight-through capabilities to complex heterogeneous networks that combine a variety of wireless and wired technologies. ***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.	2.207	3.562	3.944
Title: Information Exchange	1.280	1.270	2.287

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Description: This effort will develop software that integrates sensor data from local and external information sources and develop 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. ***FY 2015 Accomplishments:*** Developed and characterized text, image, and full motion video processing algorithms for use within representative state transfer services operating across a suite of distributed nodes using realistic network connectivity and data sources. ***FY 2016 Plans:*** 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.			
Title: Language Translation ***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 2015 Accomplishments:*** Developed, refined, and tested advanced algorithms to improve machine translation technologies by incorporating data subset selection techniques into algorithms to generalize existing machine translation modules to new domains of military interest. ***FY 2016 Plans:*** Implement and validate advanced algorithms that improve machine translation technologies by incorporating data selection techniques into algorithms to generalize existing machine translation modules; and increase ability to translate low density languages of military interest to include key languages native to Africa. ***FY 2017 Plans:***	2.139	2.053	2.647

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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.			
Title: Network Theory ***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 2015 Accomplishments:*** Developed and characterized ultraviolet (UV) communications components that attach to the standard radio frequency (RF) common sensor radio; used simulation to investigate how mobility and autonomy may be exploited to maintain connectivity; and investigated mapping connectivity regions to blend with mobility planning and sensing. ***FY 2016 Plans:*** Implement UV communications components that attach to the 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.	1.158	1.400	1.415
Title: Heterogeneous Computing and Computational Sciences ***Description:*** This effort researches and develops software algorithms to allow information processing across different computing hardware platforms. The goal of this research is to provide high performance computing (HPC) equivalent processing capabilities to the Soldier on the battlefield. ***FY 2015 Accomplishments:*** Investigated approaches for computational off-loading to disparate, hybrid cores focused on extracting maximum performance from the parallel nature of many-core pervasive technologies; created new models to describe offered load and computational	1.426	1.673	1.685

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
capacity within local tactical cloud-based services in Army-centric mobile and ad hoc networked devices; and developed software engineering protocols and methods to promote portability while maintaining efficiency with heterogeneous systems. ***FY 2016 Plans:*** Design an auto-tuning approach to balance performance models for hybrid cores where low-level instruction scheduling is a problem; implement new mathematical algorithm to address placement of mobile HPC in dynamic battlefield networks; and design 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.			
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 2015 Accomplishments:*** Developed and extended capabilities to couple multi-scale/multi-physics software that will be designed to achieve efficiency across a growing base of computing cores; and investigated the use of domain specific languages to couple novel HPC capabilities within the material modeling domain and facilitate rapid software deployment. ***FY 2016 Plans:*** Develop hierarchical multi-scale models for material behavior and design; use multiple parallel model couplings to tie models of different length or time scales together; investigate emerging programming languages for scalability and portability on different HPC computing platforms; and investigate applicability of emerging programming languages for the specific class of multi-physics applications related to underbody blast applications which includes modeling of the Soldier.	1.056	1.002	-
Accomplishments/Planned Programs Subtotals	10.514	12.656	13.811

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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*

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2017 Army	Date: February 2016
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*

COST ($ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	66.582	80.909	67.416	-	67.416	70.683	74.519	75.986	77.555	-	-
855: *Topographical, Image Intel & Space*	-	15.319	16.116	17.621	-	17.621	18.530	18.595	18.967	19.346	-	-
H71: *Meteorological Research For Battle Command*	-	6.442	6.455	6.476	-	6.476	6.590	5.632	5.762	5.897	-	-
T40: *Mob/Wpns Eff Tech*	-	26.731	26.514	28.142	-	28.142	29.830	34.462	35.139	35.842	-	-
T41: *Mil Facilities Eng Tec*	-	5.542	5.845	6.216	-	6.216	6.437	6.477	6.593	6.725	-	-
T42: *Terrestrial Science Applied Research*	-	5.161	5.158	5.152	-	5.152	5.343	5.377	5.482	5.621	-	-
T45: *Energy Tec Apl Mil Fac*	-	3.387	3.321	3.809	-	3.809	3.953	3.976	4.043	4.124	-	-
T53: *Military Engineering Applied Research (CA)*	-	4.000	17.500	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 technologies for adaptive and expedient force protection across the range of military operations. This project also designs and evaluates software and hardware to identify and mitigate positive and negative ground obstacles; characterizes austere navigation environments and designs/evaluates materiel solutions including rapidly emplacable bridging, ground stabilization, and breakwater structures; 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; and creates tools (including advanced models and simulation) that provide a framework for making trades and decisions, and also 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.

Exhibit R-2, RDT&E Budget Item Justification: PB 2017 Army	Date: February 2016
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*

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) and PE 0603125A (Combating Terrorism, Technology Development).

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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Previous President's Budget	67.302	63.409	67.350	-	67.350
Current President's Budget	66.582	80.909	67.416	-	67.416
Total Adjustments	-0.720	17.500	0.066	-	0.066
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	17.500			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.720	-			
• Adjustments to Budget Years	-	-	0.066	-	0.066

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

	FY 2015	FY 2016
Project: T53: *Military Engineering Applied Research (CA)*		
Congressional Add: *Program Increase*	4.000	17.500
Congressional Add Subtotals for Project: T53	4.000	17.500
Congressional Add Totals for all Projects	4.000	17.500

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
855: *Topographical, Image Intel & Space*	-	15.319	16.116	17.621	-	17.621	18.530	18.595	18.967	19.346	-	-

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 supports the Army Science and Technology Command, Control, Communications and Intelligence (C3I) Portfolio.

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 2015	FY 2016	FY 2017
Title: Terrain Analysis for Signal and Sensor Phenomenology	2.608	2.248	-
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.			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
FY 2015 Accomplishments: Developed advanced collection and processing strategies for the exploitation and visualization of high-fidelity, persistent remote sensing technologies (e.g., LiDAR, Hyperspectral imaging) for the generation of geospatial foundation data, rapid detection of change, dynamic terrain characterization, object identification and tracking to support ground operations, surveillance, and force protection. ***FY 2016 Plans:*** Develop initial algorithms to exploit three-dimensional (3D) terrain data using hyper-spectral data sources; Analyze 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 2015 Accomplishments:*** Developed methods to process and quantify relationships in typically non-exploitable data (i.e., social media and open source data) of a highly qualitative and unstructured nature. Efforts added novel context to conventional quantitative data sources and information, thereby providing increased awareness and surveillance of both the human and physical dimensions. Developed automated workflows to provision high-resolution imagery and geodata to mobile, dismounted devices for mission command platforms in mounted and mobile computing environments. Developed open geospatial techniques to process and transform massive datasets rapidly and accurately into usable knowledge that will be sharable across the Army Geospatial Enterprise enabling a common situational understanding through a standard, shareable geospatial foundation. ***FY 2016 Plans:*** Investigate and develop geospatial analysis tools leveraging authoritative Department of Defense (DoD) databases to support military planning; Develop methods to efficiently query databases in multiple Computing Environments to produce geospatial overlays depicting elements of sociocultural behavior; conduct research methods allowing Army planners to exploit the Standard,	2.438	4.970	-

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Shareable, Geospatial Foundation (SSGF) data and services to provide a common geospatial framework for commanders and their staff.			
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 2015 Accomplishments:*** Developed methods for super-resolution data processing (i.e., imagery, Light Detection and Ranging, Hyperspectral, multispectral), and algorithms to exploit this data. This research is specific to challenges faced by small units in urban environments that can be addressed through high-fidelity geospatial data. Initiated development for a geo-environmental framework to analyze and predict weather, model and observe terrestrial and environmental data, and geospatial information into a risk-based ensemble system to support predictive battlespace preparation. ***FY 2016 Plans:*** Develop methods to deliver and integrate novel geospatial products using open standards and formats into the AGE. Begin research on information fusion to evaluate accuracy and relevance of dynamic terrain information layers that support the military decision making process; Initiate methods to leverage and develop open source LIDAR processing capabilities to enhance feature classification and sensor exploitation. Develop stand-off soil moisture assessments and comparisons to further assist real-time mapping of moisture levels, assisting in mobility forecasts. Begin research on information fusion to evaluate accuracy and relevance of dynamic terrain information layers that support the military decision making process.	5.958	6.082	-
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 2015 Accomplishments:***	4.315	2.816	-

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Developed algorithms and methods to automatically create narratives in a geospatial format by inferring connections, relating events, times, locations, and actors; this effort facilitates the existing laborious and manual process of correlating such objects, and serves to automate the discovery of information in a geospatial context. Investigated the unique capability to characterize sub-national populations, environmental degradation, and risks to security in complex operational environments based on accessible pre-conflict data. ***FY 2016 Plans:*** Develop data mining algorithms to support discovery of relevant information and patterns contained within large, multi-modal, and multi-scale spatially and temporally referenced datasets; Explore new exploitation techniques and algorithms to characterize the urban operational environment and develop geospatial products focused on hazardous terrain identification; Enhance the capability to capture and visualize dynamic spatiotemporal narratives that describe relationships of people, events, and geographic locations through time; Develop the capability to characterize the relationship between environment and conflict through systems models that demonstrate the impacts of environmental conditions on stability. Develop algorithms to incorporate sociocultural factors and data for more effective analysis of violent events.			
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 model 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 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.	-	-	4.940
Title: GeoIntelligence - Terrestrial Remote Sensing and Data Visualization	-	-	4.462

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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.			
Title: Human Geography - Spatial Reasoning, Analysis, and Visualization ***Description:*** This effort integrates behavior and population dynamics research and analysis to depict the operational environment including culture, demographics, terrain, climate, and infrastructure, into geospatial frameworks. Research exploits existing open source text, leverages multi-media and cartographic materials, and investigates data collection methods to ingest geospatial data directly from the tactical edge to characterize parameters of social, cultural, and economic geography. Results of this research augment existing conventional geospatial datasets by providing the rich context of the human aspects of the operational environment, which offers a holistic understanding of the operational environment for the Warfighter. 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.	-	-	2.007
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.	-	-	2.455

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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.			
Title: Map-Based Planning Services (MBPS) ***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 AGE 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 0603734A/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	-	-	3.757
Accomplishments/Planned Programs Subtotals	15.319	16.116	17.621

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H71: *Meteorological Research For Battle Command*	-	6.442	6.455	6.476	-	6.476	6.590	5.632	5.762	5.897	-	-

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.

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

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 PM-Meteorological and Target Identification Capabilities (PM-MaTIC) and Marine Corps Systems Command (MCSC) for field artillery systems, the Project Manager, Distributed Common Ground System-Army (DCGS-A), the Joint Improvised Explosive Device (IED) Defeat Organization, 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 2015	FY 2016	FY 2017
Title: Atmospheric Characterization, Modeling, and Impacts (formerly Atmospheric Modeling)	2.562	2.558	5.126
Description: This effort develops high resolution, short-range forecasting, and high resolution atmospheric modeling capabilities for mountainous, urban, and forest complex terrain.			
FY 2015 Accomplishments: Developed the Atmospheric Boundary Layer Environment (ABLE) microscale (local) weather prediction model and matured the capability to implement this model in the mesoscale Weather Running Estimate-Nowcast (WRE-N) model to provide and increase			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
the reliability of local weather forecasts; developed new techniques for using data from traditional and non-traditional weather sources (i.e., surface observations, radar, light detection and ranging (LIDAR)) to produce more accurate forecast model grids of Soldier-focused parameters (e.g., wind direction for improved plume dispersion in urban domains); and implemented the ABLE model capability for artillery target area domains. ***FY 2016 Plans:*** Complete WRE-N accuracy assessments with applications to Army aviation, artillery, and dismounted operations; evaluate potential improvements to artillery firings by implementing three-dimensional forecast datasets into targeting solutions; develop 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/LIDAR, global positional system (GPS) techniques, and satellite imagery or radiances; extend WRE-N's grid spacing resolution to hundreds of meters; and develop 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.			
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-autonomous systems. ***FY 2015 Accomplishments:***	1.964	1.972	-

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Developed the Meteorological Sensor Array (MSA) at White Sands Missile Range, NM, to collect highly-detailed meteorological field measurements for precise atmospheric characterization and weather forecast model verification; determined the performance effectiveness of dual-band (midwave infrared (MWIR) and long wavelength IR (LWIR)) thermal polarimetric imagers to discriminate camouflage under varying environmental conditions; conducted experiments to determine vulnerabilities of various camouflage materials when simultaneously exposed to dual-band thermal polarimetry; developed elevation and location correction algorithms to more accurately detect and track UASs by acoustic arrays; and developed elevation correction due to atmospheric propagation for UAS tracking by acoustic arrays. ***FY 2016 Plans:*** Design and develop MSA components that provide, non-standard sensing capabilities for the atmospheric boundary layer; investigate developing an array at an alternate site in order to study atmospheric characteristics in different climatic/terrain regimes; and develop 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)	1.916	1.925	1.350
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 boundary layer meteorological (MET) measurements into high resolution models and decision aids and verifies these improvements with field measurements. ***FY 2015 Accomplishments:*** Researched tactical network capabilities to identify the most efficient methods to transmit/receive weather data for mobile weather decision aid applications; matured techniques and algorithms for integrating forecast grids into weather DSTs and implement initial capabilities in those systems; continued research of underlying methodologies to develop and transition a DST that quantifies and displays friendly versus enemy system/operations performance due to weather-related impacts; developed a DST to exploit anomaly image quality metrics for detecting areas of interest within optical images; and researched how weather affects human behavior and began development of a prediction system for threat personnel biometeorological impacts and insurgent/terrorist activities. This system will correlate existing or predicted weather conditions with possible insurgent/terrorist activities, such as IED emplacement. ***FY 2016 Plans:*** Prepare the ABLE microscale model for transition into the DCGS-A architecture; research and develop an initial capability to ingest and depict probabilistic forecast data into DCGS-A weather impacts DSTs; and mature automated algorithms and methods for the microscale model initial and boundary conditions using data from WRE-N mesoscale model results. The microscale and			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
WRE-N nowcasting model results (rapidly updated local short-term predictions) will be 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.			
Accomplishments/Planned Programs Subtotals	6.442	6.455	6.476

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
T40: *Mob/Wpns Eff Tech*	-	26.731	26.514	28.142	-	28.142	29.830	34.462	35.139	35.842	-	-

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 and overcoming battlespace gaps (such as cliffs, ravines, mudflats, shallow rivers, and other natural obstacles); prediction, definition, avoidance, or defeat of the gaps; 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 further 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 at smaller bases that are remote or integrated with local communities.

Work in this project supports the Army Science and Technology Ground Maneuver, and Command, Control, Communications, and Intelligence (C3I), 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.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Title: Adaptive Protection	10.459	10.521	11.173
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 small bases, techniques to protect, conceal, or deter against advanced threats including missiles, and techniques to identify tunnels and subterranean activities.			
FY 2015 Accomplishments: Developed technologies to determine vulnerability of critical facilities and to assess degradation to operational capability; developed protective measures that use indigenous materials and on-site production capability; provided integrated protection planning tools that include pre-deployment, construction, operations, and relocation.			
FY 2016 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Develop 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). Develop force protection technologies to mitigate lethality of advanced threats in order to increase survivability of personnel, critical assets, and fixed facilities. Develop and improve 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.			
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 2015 Accomplishments:*** Developed technologies to rapidly and remotely assess the conditions of potential airfields and ports to support operational movement and maneuver in austere/denied locations using space-based/underwater operational remote sensors. Developed a simulation capability to enable rapid remote assessment of real-time structural capacity of infrastructure (airfields, ports, and roads), river, estuary, and near shore. ***FY 2016 Plans:*** Develop computational test bed applications to simulate the influence of dynamic environmental effects created by vehicles and humans on sensor-based perception. Develop computational test bed applications to simulate the influence of dynamic environmental effects created by vehicles and humans on sensor-based perception. Complete modeling of dismounted operations and continue to develop the distribution management tool and provide systems integration to simulate the entire logistics distribution network. Complete development of the capability to numerically simulate infrasonic sources for regional assessment of infrastructures. Refine 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	13.629	12.760	12.766

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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.			
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, for sensor-target pairing, and for intelligent autonomous navigation and tactical behaviors in unmanned ground systems. This effort further investigates the design of non-line-of-sight and beyond 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 2015 Accomplishments:*** Validated three-dimensional source models of human and vehicular traffic in complex environments to determine transduction mechanisms of linear sensors; and developed physics-based model of linear sensor excitation by high-fidelity viscoelastic and discrete element methods. ***FY 2016 Plans:*** Develop high performance computing (HPC)-enabled models that simulate the geo-environmental impact on performance of multi-modal imaging sensor combinations for threat scenarios. Develop 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.	1.479	2.000	2.965
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 material and performance characteristics when used in protecting facilities. ***FY 2015 Accomplishments:*** Developed and enhanced the fidelity and efficiency of multi-scale predictive design tools to incorporate materials by design principles for development of enhanced protective structures; developed and integrated novel multi-scale reinforced cementitious	1.164	1.233	1.238

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
materials and components of protective structures; developed additive manufacturing methodologies to facilitate and optimize multi-scale reinforcement augmentation to tailor performance, facilitate manufacture and construction, and accelerate transition of this technology to the Warfighter. ***FY 2016 Plans:*** Enhance materials by design of cementitious and polymer composite protective materials through the continued development and validation of multi-scale predictive design tools; develop methods to control bonds between reinforcement and cementitious matrices at multiple scales to optimize composite performance; integrate 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.			
Accomplishments/Planned Programs Subtotals	26.731	26.514	28.142

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
T41: *Mil Facilities Eng Tec*	-	5.542	5.845	6.216	-	6.216	6.437	6.477	6.593	6.725	-	-

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 US 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.

Work in this project supports the Army Science and Technology Innovation Enablers (formerly Enduring Technologies) and Command, Control, Communications, and Intelligence (C3I) 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.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Title: Adaptive and Resilient Installations	3.040	3.122	3.620
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 2015 Accomplishments: Completed sustainment, restoration, and modernization decision models that provide installation managers with information necessary to identify actionable operations and investment opportunities to lower energy usage while maintaining mission functionality, thereby reducing facility lifecycle costs; Completed integrated modeling capability building on the Net Zero Energy Framework to support Installation planning for energy, water, and waste resource optimization.			
FY 2016 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Research the necessary mixture design and admixtures requisite to allow additive construction using cementitious materials across the broadest possible locations and operating environments. Determine the correct formulations to adapt locally available cementitious materials to required rheology, curing time, and strength for automated additive construction of expeditionary structures. Determine 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 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.			
Title: Human Geography – Fundamentals of Behavior and Population Dynamics (Previously titled Social/Cultural Behavior)	2.502	2.723	2.596
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/Project 855. ***FY 2015 Accomplishments:*** Investigated the unique capability to characterize sub-national populations, environmental degradation, and risks to security in complex operational environments based on accessible pre-conflict data; investigated monitoring tools and decision models reflecting effects of changing conditions on the operating environment for Brigade-level operators and mission planners; identified levers of change impacting urban security operating environments to provide timely answers to Commanders on whether the effects of actions support the desired strategy. ***FY 2016 Plans:*** Investigate 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; develop methods to produce composite geospatial products from multiple human and environmental data inputs and semi-automated analytic tools; investigate 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:***			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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..			
Accomplishments/Planned Programs Subtotals	5.542	5.845	6.216

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: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
T42: *Terrestrial Science Applied Research*	-	5.161	5.158	5.152	-	5.152	5.343	5.377	5.482	5.621	-	-

A. Mission Description and Budget Item Justification

This effort provides technologies which support analysis of socio-cultural and facility issues in forward base operations, including urban environments. Technology development efforts will include means to identify dynamic signatures, or indicators, in the socio-cultural realm to assist in estimating or predicting behavioral response to operations.

Work in this project supports the Army Science and Technology Command, Control, Communications and Intelligence (C3I) 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 2015	FY 2016	FY 2017
Title: Analysis for Signal & Signature Phenomenology	1.651	2.722	-

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 2015 Accomplishments:
Researched and developed a framework to significantly improve geospatial tools that inform mission command systems and the common operational picture by quantifying and displaying risk and uncertainties inherent in data quality of terrestrial properties (soils, vegetation, landscape, structures), weather influences (rapid dynamic changes), and information collection modalities (seismic, acoustic, radio frequency, electro-optical propagation); investigated potential uses of full waveform Light Detection and Ranging (LiDAR) backscatter remote sensing of terrestrial surfaces for remote classification of terrestrial material properties and characterization for geospatial applications.

FY 2016 Plans:
Investigate methods and advanced tools for storing, indexing, and managing raw LiDAR sensor data in a geospatial database enabling immediate remote processing and exploitation for tactical terrain analysis; develop techniques for fusing disparate data

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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) ***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 (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. ***FY 2015 Accomplishments:*** Researched and established an Environmental Intelligence modeling framework supporting broad Army mission utility including trainers, Soldiers, planners, and materiel developers, with real world operational environment terrestrial and climate modeling integral to training scenarios, mission planning, and materiel performance, through geospatial tools depicting terrain and climate influences in a unit's operational environment, landscape and climate impacts to stability operations (land use, water resources), courses of action (COA) development, and capability development analysis of alternatives (AoA). ***FY 2016 Plans:*** Initiate 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. Initiate evaluation of acoustic, seismic, and radiofrequency (RF) modeling complexities in complex urban and terrain environments where signals are impacted by scattering objects. Conduct 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. Investigate 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.	3.510	2.436	3.500
Title: GeoIntelligence - Terrestrial Phenomenology Characterization for Geospatial Applications (Formerly Analysis for Signal & Signature Phenomenology) ***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.	-	-	1.652

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
FY 2017 Plans: 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.			
Accomplishments/Planned Programs Subtotals	5.161	5.158	5.152

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
T45: *Energy Tec Apl Mil Fac*	-	3.387	3.321	3.809	-	3.809	3.953	3.976	4.043	4.124	-	-

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 matures 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 (formerly Enduring Technologies) 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 2015	FY 2016	FY 2017
Title: Adaptive and Resilient Installations	3.387	3.321	3.809

Description: This effort investigates and develops technologies necessary for energy efficient and sustainable military installations, emphasizing energy and utility systems.

FY 2015 Accomplishments:
Developed sustainment, restoration, and modernization decision models that provide installation managers with information necessary to identify actionable operations and investment opportunities to lower energy usage while maintaining mission functionality, thereby reducing facility lifecycle costs. Investigated use of indigenous materials for forward operating bases and contingency bases; investigated smart and multifunctional materials and systems that increase strength, durability, resilience, and electromagnetic shielding for buildings and hard shelter envelopes.

FY 2016 Plans:
Investigate the impacts on energy efficiency and lifecycle sustainability of contingency basing structures constructed with cementitious materials assembled via an additive process for construction. Investigate the impacts on construction geometries of the structures along with the physical attributes of the supporting pad, walls, and ceiling. Evaluate material mixtures and

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
additives, as well as nozzle shapes and combinations, to allow complex wall configurations to improve thermal characteristics while maintaining structural integrity. ***FY 2017 Plans:*** 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.			
Accomplishments/Planned Programs Subtotals	3.387	3.321	3.809

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
T53: *Military Engineering Applied Research (CA)*	-	4.000	17.500	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 2015	FY 2016
Congressional Add: Program Increase ***FY 2015 Accomplishments:*** Program increase for military engineering applied research ***FY 2016 Plans:*** Program increase for military engineering applied research	4.000	17.500
Congressional Adds Subtotals	4.000	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: PB 2017 Army	Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	21.280	24.735	26.045	-	26.045	24.910	25.184	25.679	26.193	-	-
790: *Personnel Performance & Training Technology*	-	21.280	24.735	26.045	-	26.045	24.910	25.184	25.679	26.193	-	-

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 program element 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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Previous President's Budget	23.288	24.735	26.045	-	26.045
Current President's Budget	21.280	24.735	26.045	-	26.045
Total Adjustments	-2.008	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-1.500	-			
• SBIR/STTR Transfer	-0.508	-			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
790: *Personnel Performance & Training Technology*	-	21.280	24.735	26.045	-	26.045	24.910	25.184	25.679	26.193	-	-

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 program element 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. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Title: Personnel	4.377	8.296	14.050
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 2015 Accomplishments: Conducted longitudinal validation of non-cognitive measures for awarding Reserve Officers Training Corps (ROTC) scholarships to high-potential officer candidates. Continued validation of the Information/Communications Technology Literacy Test (ICTL) as a measure to predict performance in cyber-related domains.			
FY 2016 Plans: Developing and validating new individual difference measures for predicting the job performance of Army strategic planners; developing a scientifically valid combination of pre-commissioning indices and non-cognitive measures for predicting officer job			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
performance across multiple branches/functional areas; developing new assessments for predicting performance in cyber-related jobs. ***FY 2017 Plans:*** 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.			
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 2015 Accomplishments:*** Developed training methods that expedite training across a range of tasks and training environments. Conducted training research to improve Non-Commissioned Officers' (NCOs) ability to develop junior Soldiers. Developed strategies (e.g., training) for small unit leaders to create ready and resilient units. ***FY 2016 Plans:*** Developing assessment methods and identifying pre-cursor factors for unit resilience to enhance unit and Soldier readiness. Designing and developing exemplar measures, methods, and resources to support effective training and leader development for junior NCOs. Designing and developing prototype measures and methods for small-unit leaders to improve Soldier readiness. Developing 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.	7.738	11.863	5.795
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. Will develop methods to enable leaders and units to ensure climates of dignity, respect, and inclusion. ***FY 2015 Accomplishments:***	9.165	4.576	6.200

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Developed innovative methods and techniques to develop leader skills (e.g., techniques for mentorship, coaching, and subordinate development). Continued research to develop innovative training methods for Sexual Harassment/Assault Response and Prevention (SHARP). ***FY 2016 Plans:*** Conduct research on empathy-based training methods to prevent and reduce the incidence of sexual harassment and assault; develop 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.			
Accomplishments/Planned Programs Subtotals	21.280	24.735	26.045

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: PB 2017 Army	Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	31.597	39.295	37.403	-	37.403	34.475	35.567	36.303	37.029	-	-
283: *Airdrop Adv Tech*	-	2.392	3.085	3.432	-	3.432	2.813	2.773	2.827	2.884	-	-
E01: *Warfighter Technology Initiatives (CA)*	-	6.300	3.500	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-
H98: *Clothing & Equipm Tech*	-	18.589	27.642	26.571	-	26.571	23.407	24.576	25.096	25.598	-	-
H99: *Joint Service Combat Feeding Technology*	-	3.029	3.310	4.919	-	4.919	5.030	5.066	5.164	5.267	-	-
VT4: *Expeditionary Mobile Base Camp Technology*	-	1.287	1.758	2.481	-	2.481	3.225	3.152	3.216	3.280	-	-

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 Program Element 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: PB 2017 Army	**Date:** February 2016
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*

B. Program Change Summary ($ in Millions)	**FY 2015**	**FY 2016**	**FY 2017 Base**	**FY 2017 OCO**	**FY 2017 Total**
Previous President's Budget	32.044	35.795	34.603	-	34.603
Current President's Budget	31.597	39.295	37.403	-	37.403
Total Adjustments	-0.447	3.500	2.800	-	2.800
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	3.500			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.447	-			
• Adjustments to Budget Years	-	-	2.800	-	2.800

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2015**	**FY 2016**
Project: E01: *Warfighter Technology Initiatives (CA)*		
Congressional Add: *Program Increase*	6.300	3.500
Congressional Add Subtotals for Project: E01	6.300	3.500
Congressional Add Totals for all Projects	6.300	3.500

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
283: *Airdrop Adv Tech*	-	2.392	3.085	3.432	-	3.432	2.813	2.773	2.827	2.884	-	-

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 2015	FY 2016	FY 2017
Title: Airdrop/Aerial Delivery Research and Technology	2.392	3.085	3.432
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 2015 Accomplishments: Investigated wind detection methods/methodologies for precision guidance, navigation, and control; developed static line reserve parachute automatic activation technologies for future incorporation into personnel parachute systems to increase operator safety; designed system to increase safety of high altitude and military free fall parachutists through risk reduction of collision or near-miss events between automated cargo delivery systems while jumpers are also in the airspace; investigated methods/ methodologies for enhancing autonomous glide and precision delivery landing accuracy.			
FY 2016 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Investigate adaptive flight software to overcome rigging errors and broken control lines of Joint Precision Aerial Delivery System cargo parafoils; utilize 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; conduct assessment of technologies to increase airdrop system stealth capability while in flight and after impact; continue further advancements of life saving paratrooper static line reserve parachute automatic activation technologies. ***FY 2017 Plans:*** Will study, design, and conduct experiments with precision aerial delivery software and hardware components to enhance high altitude precision aerial delivery capabilities in 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.			
Accomplishments/Planned Programs Subtotals	2.392	3.085	3.432

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
E01: *Warfighter Technology Initiatives (CA)*	-	6.300	3.500	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 2015	FY 2016
Congressional Add: Program Increase	6.300	3.500
FY 2015 Accomplishments: Program Increase		
FY 2016 Plans: Program Increase		
Congressional Adds Subtotals	6.300	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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H98: *Clothing & Equipm Tech*	-	18.589	27.642	26.571	-	26.571	23.407	24.576	25.096	25.598	-	-

A. Mission Description and Budget Item Justification

This project investigates components and materials focused on enhancing Soldier survivability from combat threats (flame and thermal threats, blast and ballistic threats, and lasers) and environmental threats (e.g., cold, heat, and wet) to increase operational effectiveness while decreasing the Soldier's physical and cognitive burden. Included are technologies and novel materials related to personnel armor, helmets, hearing protection, and eyewear. 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 Program Element (PE) is fully coordinated with PE 0602105A (Materials Technology), PE 0602618A (Ballistics Technology), PE 0603001A (Warfighter Advanced Technology), PE 0602787A (Medical Technology Initiatives), and PE 0602716A (Human Factors Engineering Technology).

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 2015	FY 2016	FY 2017
Title: Soldier Blast and Ballistic Protection	4.010	5.909	6.858
Description: This effort supports the investigation of novel materials, component design, and material modeling to design and develop technologies that protect Soldiers against ballistic and blast 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, and PE 0603001A/Project J50. 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 2015 Accomplishments: Designed predictive models for estimation of performance of ballistic fibers after exposure to adverse operational and storage environments; investigated laboratory methods of simulating and measuring forces and accelerations induced by blast overpressure on soldiers wearing headborne equipment; designed and evaluated reduced weight head and torso protection concepts for small arms and fragment protection using novel materials and assembling approaches; continued development of advanced modeling, simulation, and assessment tools that define ballistic and blast survivability/mobility/lethality trade space;			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
developed a standardized methodology to assess anthropometric design (fit, area of coverage, and comfort) impacts on body armor system performance. ***FY 2016 Plans:*** Complete development of laboratory method of simulating and measuring forces and accelerations induced by blast overpressure on headborne equipment; investigate concepts for improving the above method through inclusion of a biofidelic neck that provides accurate, gender-specific simulation of the dynamic mechanical behavior of the human neck to improve the validity of the results; continue 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; complete development of standardized methodology to assess anthropometric design (fit, area of coverage, and comfort) impacts on body armor system performance. ***FY 2017 Plans:*** Will 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.			
Title: Soldier Vision Protection and Enhancement ***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, and PE 0603001A/Project J50. ***FY 2015 Accomplishments:*** Matured active and passive technologies for providing improved eye protection against ballistic and laser threats; demonstrated proof of concept for active variable transmission lenses for enhanced situational awareness in rapidly changing light level conditions; developed novel spray coating process for producing optical quality films; investigated ballistic and optical properties of novel transparent composite materials and nanomaterials that can provide >50% increase in ballistic protection compared to current materials; investigated and determined the individual locomotion and cognitive effects of rapid-transition variable transmission lenses and the trade-offs between optical distortion and the extent of eye protection against laser, flash, and ballistic fragmentation. ***FY 2016 Plans:***	3.411	4.140	3.100

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Design breadboard proof of concept for pixilated lens technology that maintains peripheral vision while mitigating laser threats; investigate feasibility of alternative material solutions for tunable laser protection that enable selective blocking of laser threats while maintaining non-threatening light transmission; investigate feasibility of enhancing Soldier vision performance (e.g., on-demand telescopic vision capability) using waveplate technology. ***FY 2017 Plans:*** Will 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	4.074	8.668	9.459
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 2015 Accomplishments:*** Designed a concept development for a suite of human systems performance measurements, approaches, and field analytical tools to support the human systems component of a Soldier Systems Engineering Architecture (SSEA); developed and evaluated metrics and optimization strategies for human physical, psychological, cognitive, and emotional performance parameters as inputs for modeling and analysis of Soldier and Small Unit combat performance; conducted trade analyses between mobility, lethality, survivability, and mission performance; investigated anthropometric approaches for developing improved fidelity models that address vital organ size and informed Soldier equipment engineering designs about location, fit, and coverage area; investigated potential for human performance applications through emerging fields such as non-medical synthetic biology. ***FY 2016 Plans:*** Continue the 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; investigate the psychological, anthropometric, and biomechanical impacts on modifications to Soldier system components and sub-systems on survivability and combat effectiveness; investigate the concept of leveraging and linking existing Soldier capabilities with			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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; design standard assessment methodologies, based on operational tasks, that define the relationship between Soldier performance and his/her equipment and configurations; design population-level analysis design tool for creating human model of Soldier's size and shape based on statistical methods; define 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:*** Will 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.			
Title: Advancements in Fibers, Textiles, and Materials for Soldier Protection ***Description:*** This effort focuses on the investigation of technologies that aid in the design and development of multifunctional protective materials and concealment concepts for Soldier clothing, equipment, and shelters. 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 2015 Accomplishments:*** Matured novel textile and fiber-based technologies to provide protection against multiple environmental threats to Soldiers and Small Units; investigated use of electrotextiles for providing protection to personnel and equipment against electromagnetic threats; investigated methods of incorporating anti-pathogenic functionality into textiles; investigated properties and methods of making novel multi-component fibers, nanofibers, and finished fabrics for use as Soldier protection against cuts/abrasion, cold weather environments, and pathogens; performed experimental proof of concept for thermal signature reduction technology concepts; developed predictive models for thermal signature performance of emerging materials; matured technologies and methods to improve visual signature management/camouflage; investigated inherently flame resistant fiber and novel coating technologies that provide significant performance improvements over Flame Resistant-Army Combat Uniform (FR-ACU) fabrics; investigated alternative fiber technologies for durable, wearable combat identification systems that enable improved visibility to friendly forces; characterized novel thermoelectric textile materials for wearable power generation and personal cooling applications. ***FY 2016 Plans:***	7.094	8.925	7.154

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Mature thermal signature reduction technologies and associated modeling tools for prediction of material performance in a range of simulated environments; continue to investigate incorporation of improved, low toxicity, narrow spectrum antimicrobial and insect repellent treatments into textiles appropriate for Soldier clothing and individual equipment; mature improved flame resistant and no melt/no drip fibers, coatings, and textiles for incorporation into combat clothing and individual equipment; continue development of improved combat identification technologies and electrotextiles for power generation/distribution and personal thermal management. ***FY 2017 Plans:*** Will 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/ 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.			
Accomplishments/Planned Programs Subtotals	18.589	27.642	26.571

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
H99: *Joint Service Combat Feeding Technology*	-	3.029	3.310	4.919	-	4.919	5.030	5.066	5.164	5.267	-	-

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 PE 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 2015	FY 2016	FY 2017
Title: Joint Combat Feeding Equipment and Food Protection Technologies	1.429	-	-
Description: This effort investigates technologies in support of the DoD Veterinary Service Activity (VSA) 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 Services field feeding operations in a wide range of environmental and operational contexts.			
FY 2015 Accomplishments:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Explored technology for elimination/prevention of pathogens in fresh fruit and vegetables; designed methods to significantly reduce detection times for viable pathogens; investigated novel technologies to promote Joint field feeding operations and reduce field feeding logistical footprint.			
Title: Ration Stabilization and Novel Nutrient Delivery Technologies ***Description:*** This effort designs and develops stabilization techniques and nutrient compositions to maximize the Warfighter's cognitive and physical performance while minimizing nutritional degradation in order to optimize the Warfighter's health while on the battlefield. ***FY 2015 Accomplishments:*** Explored nutrient delivery methods within rations to ensure optimal Warfighter nutrition and performance; investigated emerging technologies to produce lightweight, condensed, shelf-stable rations that reduce refrigeration requirements in field environments; explored novel processing and stabilization technologies to improve acceptability and increase consumption while meeting shelf-stability requirements, extending ration life-cycle, and reducing cost.	1.600	-	-
Title: Joint Combat Feeding Technologies ***Description:*** Beginning in Fiscal Year (FY) 2016, Joint Combat Feeding Equipment and Food Protection Technologies and Ration Stabilization, Packaging, Novel Nutrient Delivery, and Food Safety Technologies will be combined and named Joint Combat Feeding Technologies. 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 DoD VSA 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 Plans:*** Investigate alternate refrigerant systems in support of containerized deployable refrigeration assets to address environmental concerns with current generation refrigerants; investigate 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; investigate novel food processing technologies in support of improved nutrient retention, reduced manufacturing costs, and increased consumer acceptability; investigate and develop optimized	-	3.310	4.919

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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:*** Will 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.			
Accomplishments/Planned Programs Subtotals	3.029	3.310	4.919

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
VT4: *Expeditionary Mobile Base Camp Technology*	-	1.287	1.758	2.481	-	2.481	3.225	3.152	3.216	3.280	-	-

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 Program Element (PE) is fully coordinated with 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 2015	FY 2016	FY 2017
Title: Expeditionary Base Camp Component Technologies	1.287	1.758	2.481
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 2015 Accomplishments: Investigated emerging technology approaches (e.g., ion-exchange) for handling and treatment of black waste to ensure a hygienic environment and protect Soldier health and readiness at combat outposts; explored self-sufficiency solutions that minimize			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
logistical needs, as well as identify opportunities for co-generation and dual-use technology approaches; investigated the benefits of nonwoven textiles for potential shelter technology applications to achieve a 20% weight reduction over current woven fabrics. ***FY 2016 Plans:*** Investigate increased flame resistance for shelter materials and fire safety for shelters to ensure Soldiers are provided with safe living environments; mature novel materials for power generating shelter materials to decrease logistical burden and fuel demands; research rapid expeditionary basing deployment techniques to increase efficiency and support a leaner force; investigate technologies that support self-sufficiency of basing logistics; mature components of black waste systems to ensure a hygienic environment; design lightweight novel multifunctional panel materials for rigid wall shelters; investigate multifunctional materials for basing applications that can produce increased protections for overmatch capabilities and reduce exposure to insects. ***FY 2017 Plans:*** Will 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.			
Accomplishments/Planned Programs Subtotals	1.287	1.758	2.481

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: PB 2017 Army	Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
Total Program Element	-	74.285	76.853	77.111	-	77.111	82.334	82.912	84.549	86.586	-	-
869: *Warfighter Health Prot & Perf Stnds*	-	30.929	30.043	37.409	-	37.409	39.213	39.462	40.244	41.369	-	-
870: *Dod Med Def Ag Inf Dis*	-	17.426	19.245	20.478	-	20.478	22.144	22.624	23.074	23.403	-	-
874: *Cbt Casualty Care Tech*	-	15.394	17.005	10.033	-	10.033	11.598	9.868	10.052	10.380	-	-
ET4: *Appl Resch in Clinical and Rehabilitative Medicine*	-	0.000	0.000	7.273	-	7.273	7.378	8.948	9.130	9.343	-	-
FH2: *Force Health Protection - Applied Research*	-	5.856	5.278	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-
VB4: *System Biology And Network Science Technology*	-	4.680	5.282	1.918	-	1.918	2.001	2.010	2.049	2.091	-	-

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: PB 2017 Army		Date: February 2016
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602787A / *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 and wound infections of military importance, 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 (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 protocols 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, and bone tissue for the care and treatment of combat trauma casualties. 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. In FY17 the Clinical and Rehabilitative Medicine efforts will be funded in 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 battle-injured casualties. 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 the 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 an 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.

Exhibit R-2, RDT&E Budget Item Justification: PB 2017 Army	Date: February 2016
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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 project PE is fully coordinated with efforts undertaken in PE 0603002A 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 Dental Trauma Research Detachment and 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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total
Previous President's Budget	76.044	76.853	77.111	-	77.111
Current President's Budget	74.285	76.853	77.111	-	77.111
Total Adjustments	-1.759	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.759	-			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army												Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
869: *Warfighter Health Prot & Perf Stnds*	-	30.929	30.043	37.409	-	37.409	39.213	39.462	40.244	41.369	-	-

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
(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, project MM3.

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 Styates Army Aeromedical Research Laboratory (USAARL), Fort Rucker, AL.

Efforts in this project support the Soldier Portfolio and the principal areas of Combat Casualty Care and Military Operational Medicine.

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Title: Physiological Health - Nutritional Sustainment and Fatigue Interventions	3.534	2.617	3.105
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 2015 Accomplishments:*** Established nutrition approaches that promoted resistance to physical, cognitive and environmental stressors and promoted muscle and bone recovery. Developed next generation predictive algorithms that estimated overheating for incorporation into wearable sensor systems. Established sensors and bio-mathematical models (math equations to explain biological processes) capable of predicting cognitive status and likelihood of risk for musculoskeletal (muscle, bone, tendons, and ligaments) injury. Determined patterns of physiological (human mechanical, physical, and biochemical functions), behavioral, and cognitive-affective responses in individuals during exposure to multiple stressors and developed a working operational definition of physiological resilience and algorithms to predict individualized resilience. ***FY 2016 Plans:*** Determine the role of eating rate in energy balance. Establish the effects of nutritional interventions on the localized immune response during wound healing. Determine the effectiveness of novel feeding platforms (dining facility organization) for the improvement of dietary quality during garrison feeding. Determine relevant predictors, moderators and outcome metrics that enhance the ability to predict a Warfighters capacity to recover quickly, both mentally and physically. Establish 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.			
Title: Concussion/Mild Traumatic Brain Injury (mTBI) Interventions	-	-	2.422
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: PB 2017 Army		Date: February 2016
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
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.			
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 2015 Accomplishments:*** Identified physiological reflexes that improve hand and finger dexterity during cold exposure and refined localized heating strategies to improve dexterity in cold weather operations. Developed decision aids for trade-off analyses of the impact of body armor protection and load on aerobic performance capabilities in temperate and hot environments. Determined if thermoregulatory (ability of an organism to keep its body temperature within certain boundaries) fatigue and altitude exposure increase susceptibility for non-freezing cold injury symptoms including numbness. Identified biomarkers (indicator of a process, event, condition or change within the body) predictive of individual risk for developing acute mountain sickness at high altitude operations. ***FY 2016 Plans:*** Perform laboratory and field studies to refine predictive models of altitude sickness, acclimatization status, and work performance at high altitude. Develop 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. Determine 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. Determine if localized warming that will improve peripheral blood circulation will also decrease susceptibility to non-freezing cold injury. Establish the effectiveness of novel pharmaceutical treatments for heat injury	1.309	1.446	1.578

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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:*** 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.			
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.	-	-	3.925
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 2015 Accomplishments:*** Developed spinal injury criteria and protection assessment methodologies for military vehicle occupants. Developed methods for assessing the effectiveness of prevention strategies against hearing and vestibular injuries. Developed assessment criteria for	2.437	3.463	4.191

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
prediction of eye injury resulting from blunt, ballistic, and blast-wave forces, and determined injury prevention criteria for eye injury induced by repetitive blast exposures. ***FY 2016 Plans:*** Perform crash and blast relevant vertical acceleration experiments to determine improved predictions and diagnostics of spinal injury. Characterize middle ear function under impulse (sudden loud) noise for improvement of current hearing injury models. Validate test criteria, and develop 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.			
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 2015 Accomplishments:*** Developed mathematical models of functional neuromuscular adaptation (changes in the way the nervous system communicates with the musculoskeletal system) following muscle injury and determined the effect of inflammatory processes on muscle repair and regeneration. These models predicted the relative risk of re-injury, and incomplete healing. Determined the modifiable and non-modifiable risk hazards for musculoskeletal injuries. ***FY 2016 Plans:*** 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	2.031	3.054	4.481

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
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.			
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 2015 Accomplishments:*** Characterized current Warfighter injury trends in training and operations contributing to lost duty days, reduced mission effectiveness, and occupational disability. Determined the effects of physical, auditory, and visual system injury on military occupational performance and define minimal pre-RTD performance standards Warfighter. Evaluated Warfighters with traumatic brain injury (TBI) and co-morbid auditory or vision deficits. ***FY 2016 Plans:*** Develop 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. Perform 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. Determine the effects of physical injury on military occupational performance and define minimal standards for Warfighter performance prior to returning to duty.	2.952	2.636	-
Title: Psychological Health - Psychological Resilience ***Description:*** This effort refines and evaluates early interventions to prevent and reduce combat-related behavioral health problems, including symptoms of post-traumatic stress disorder (PTSD), depression, anger problems, anxiety, substance abuse, 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 2015 Accomplishments:*** Developed and disseminated validated strategies and early interventions to enhance and sustain mental health and well-being throughout the Warfighters careers and determined evidence-based recommendations for reintegration strategies. Benchmarked behavioral health problems, risk, and resilience physiological biomarkers in Warfighters and their Families. Conducted analyses of neurocognitive (relating to or involving the central nervous system and cognitive abilities) test scores associated with a wide variety of psychological RTD outcomes. Conducted studies that explored the utility of sleep monitors and neurocognitive tools for psychological RTD decision making. Assessed various mechanisms and interventions for reducing deployment-related anxiety. Developed and validated unit-based, post-deployment resilience training for Warfighters. Conducted trials with active	14.188	12.960	8.674

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
duty Warfighters assessing optimal intervention methods for PTSD, including medications. Determined the correlation between levels of individual biomarkers and PTSD interventions, i.e. supplementing the current standard of care with extended exposure to surrogate traumatic events and virtual reality, to recreate the context of the original traumatic exposure. ***FY 2016 Plans:*** Explore the effectiveness of improved sleep quality and quantity on the recovery from concussion. Perform studies to improve a Mindfulness training package to develop recommendations for Comprehensive Warfighter and Family Fitness (CSF2). Analyze data from previous studies to determine if an alcohol use screening questionnaire can be effectively used in Warfighters. Perform studies to revise Family resilience training across the deployment cycle. Develop evidence-based recommendations for identifying and addressing difficulties with post-combat adjustment. 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 reduction in anger symptoms. Perform studies to improve and validate unit-based resilience training for Reserve Components. Begin to evaluate evidence-based behavioral health leader training. Provide recommendations for provider toolkit using sleep quality parameters to inform RTD decisions. Conduct studies to understand how to best increase Warfighter use of DoD provided behavioral health care. Extend 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, identify alterations in gastrointestinal and immune response systems signaling PTSD onset. Continue 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 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			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
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.			
Title: Psychological Health & Resilience - Suicide Prevention ***Description:*** This effort supports methods to identify causative and preventive factors in military suicides. ***FY 2015 Accomplishments:*** Determined risk and protective factors associated with suicide behavior and intent. Determined effective risk assessment and management methods for suicide prevention. Delivered interventions to unit leaders and unit members following suicide events in a combat environment including interventions to manage grief and bereavement, and suicide prevention strategies. ***FY 2016 Plans:*** Continue to advance the study from FY15 efforts to determine whether a brief cognitive behavioral intervention can encourage Warfighters to seek treatment. Continue 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.	0.979	0.865	0.954
Title: Psychological Health & Resilience - Concussion/Mild Traumatic Brain Injury (mTBI) 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 other areas (Concussion/ mTBI Interventions). ***FY 2015 Accomplishments:*** Characterized sleep duration, timing, and continuity on post-concussive symptoms using objective sleep measures. Determined the relative utility of existing neurocognitive tools (computerized tests that assess different aspects of cognitive functioning such as ANAM, DANA, ImPact, AXON and others) for assessment of post-concussive symptoms. Developed algorithms to predict concussion likelihood based on post-exposure symptoms and brain injury. ***FY 2016 Plans:***	1.053	0.876	-

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Conduct 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.			
Title: Millennium Cohort Research ***Description:*** This effort supports a long-term study of Warfighters that includes psychological, physical and spiritual 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 Servicemen and women. Funding for this research effort moves from project FH2 to project 869 starting in FY17. ***FY 2017 Plans:*** 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.	-	-	5.301
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 2015 Accomplishments:*** Advanced medical S&T in the areas of injury prevention and performance sustainment in the context of human interaction with new Warfighter systems. Provided greater insight into informing new research across the S&T community (medical and non-medical) in development of Warfighter systems and the interactions between Warfighters and the systems they employ. Leveraged the work being done in Physiological Health, Injury Prevention & Reduction, both musculoskeletal (muscle, bone, tendons, and ligaments) and neurosensory, Psychological Health and Resilience and Environmental Health to inform the Warfighter Systems Engineering Architecture initiative. ***FY 2016 Plans:***	2.446	2.126	2.778

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Advance medical research in the areas of injury prevention and performance optimization in the context of human interaction with new Warfighter systems and provide 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 leverages 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 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.			
Accomplishments/Planned Programs Subtotals	30.929	30.043	37.409

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: PB 2017 Army			Date: February 2016
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / *Medical Technology*	Project (Number/Name) 870 / *Dod Med Def Ag Inf Dis*	

COST ($ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
870: *Dod Med Def Ag Inf Dis*	-	17.426	19.245	20.478	-	20.478	22.144	22.624	23.074	23.403	-	-

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 (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 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 2015	FY 2016	FY 2017
Title: Drugs to Prevent/Treat Parasitic Diseases ***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 2015 Accomplishments:*** Continued to optimize candidate drugs and drug combinations to stay ahead of emerging drug resistance in malaria parasite(s). ***FY 2016 Plans:*** Use 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. Evaluate safety and effectiveness of lead relapse curative drugs (Primaquine and Tafenoquine) 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).	3.299	5.304	-
Title: Vaccines for Prevention of Malaria ***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 2015 Accomplishments:*** Completed the development of a human challenge model for malaria; volunteers vaccinated with a malaria vaccine candidate were deliberately infected with a malarial parasite through the bite of malaria-infected mosquitoes to assess whether or not the	4.743	4.025	-

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
candidate vaccine prevented or delayed malaria infection. Tested individual novel Plasmodium falciparum (causes severe form of malaria) antigens and antigen combinations in small animals. ***FY 2016 Plans:*** Assess mechanisms of protective immunity of new malaria protein-based vaccine candidates in small animals. Evaluate 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 ***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.	-	-	10.179
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 2015 Accomplishments:*** Researched and developed pathogen specific assays for selected disease causing pathogens to expand the capability of the fielded and commercially available Rapid Human Diagnostic Devices (RHDDs). Refined pathogen detection assays and field test	1.649	1.244	1.218

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
surveillance devices developed to detect pathogens in medically important arthropods (e.g., ticks, mosquitoes and sandflies). Tested new vector repellent compounds/formulations for application to personal protection measures i.e. uniform treatment or bednets ***FY 2016 Plans:*** Develop tests to detect arthropod-borne pathogens for use on field deployable detection platform. Develop a multiplex assay (capable of detecting multiple pathogens at the same time). Conduct 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 RHDD 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.			
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 2015 Accomplishments:*** Identified and maintained vaccine test site infrastructure for evaluation of dengue vaccine candidates in human clinical trials. Assessed vaccination safety and immunogenicity data, applied this data as down selection criteria to identify superior performing vaccine candidates or administration strategies for advancement to testing of hantavirus and dengue vaccine candidates in human volunteers. Tested research strategies to develop novel assays to rapidly measure hantavirus neutralizing antibodies. ***FY 2016 Plans:*** Assess host immune responses against dengue virus antigens among experimental vaccine recipients. Expand vaccine test site infrastructure in selected communities at risk for dengue virus exposure. Improve methods for identification and characterization of protective antibodies. Assess immune vaccinated or un-vaccinated and exposure risk factors among human population groups in areas where dengue exposure is historically prevalent. 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	3.678	3.241	3.545

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Hantavirus vaccine. Upon success with the DNA vaccine approach, further develop additional DNA vaccines and combination vaccines against viruses-of-interest, e.g. Crimean Congo Hemorrhagic Fever). 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 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).			
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 2015 Accomplishments:*** Refined and evaluated vaccine candidates for Shigella and enterotoxigenic E. coli. Studied clinical grade prototype diarrheal disease vaccine candidates for animal testing. Identified and prepare vaccination field trial sites. Maintain chigger (mite) colony used as the challenge model to evaluate current Scrub typhus vaccine candidates. Identified and characterized mechanisms of antibiotic resistance occurring in scrub typhus infections. ***FY 2016 Plans:*** Down-selection from FY15 vaccine formulations, refine and evaluate vaccine candidates against each of the three major bacterial causes of diarrhea (Shigella, enterotoxigenic E. coli and Campylobacter). Study clinical grade (suitable for injection into human volunteers) diarrheal disease vaccine candidates in small animals for safety and effectiveness. Identify and prepare clinical trial field sites for evaluation of candidate vaccines. Maintain a chigger colony used as the challenge model to evaluate the effectiveness of Scrub typhus vaccine candidates. Study the mechanisms of immune protection to scrub typhus. ***FY 2017 Plans:*** 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	4.057	5.431	5.536

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
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.			
Accomplishments/Planned Programs Subtotals	17.426	19.245	20.478

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: PB 2017 Army			Date: February 2016
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COST ($ in Millions)	Prior Years	FY 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
874: *Cbt Casualty Care Tech*	-	15.394	17.005	10.033	-	10.033	11.598	9.868	10.052	10.380	-	-

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 better medical 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 aids 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, orthopedic injuries, eye injuries, genitourinary (reproductive and excretory organs) injury, and face trauma.

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 United States Army Dental Trauma Research Detachment (USADTRD), Joint Base San Antonio, TX; the Walter Reed Army Institute of Research (WRAIR), Silver Spring, MD; and the AFIRM, at Multiple Institutions across the US.

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Efforts in this project support the Soldier Portfolio and the principal areas of Combat Casualty Care and Clinical and Rehabilitative Medicine.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Title: Damage Control Resuscitation ***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 2015 Accomplishments:*** Conducted studies to determine effective means to control bleeding when clotting ability is impaired due to trauma. Conducted animal studies into how plasma (fluid component of blood) in combination with other blood products and/or drugs may stop trauma induced bleeding, reverse blood clotting problems and minimize inflammation. These studies improved Warfighter trauma survival and improve longer term treatment / recovery. ***FY 2016 Plans:*** Start animal studies to explore clinical consequences of long-term application of hemorrhage (bleeding) control products and devices. Perform 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.	3.568	3.903	4.072
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 2015 Accomplishments:*** Continued development of anti-biofilm gel (a protein gel that kills colonies of wound-infecting bacteria). Performed studies to determine means to alleviate persistent wound inflammation subsequently preventing tissue destruction and excessive scarring. ***FY 2016 Plans:*** Establish 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	1.210	1.395	2.585

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
excessive scarring. Start 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) 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.			
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 2015 Accomplishments:*** Conducted studies to identify the physiological effects of optimizing blood flow returning to the heart, as a fluidless resuscitation strategy. Continued research to optimize algorithms to improve fluid resuscitation, prevent hemorrhagic shock, and to develop decision support algorithms to guide provision of critical care to casualties at point of injury, during transport, and in field hospitals. ***FY 2016 Plans:*** Will continued studies from FY15 to identify the physiological effects of optimizing blood flow returning to the heart, as a fluidless resuscitation strategy. Complete development of first generation patient monitors using light-based sensors and integration of blood-loss prediction algorithm. Start 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.	1.329	1.993	1.417
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	7.332	7.522	-

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
abdomen) as well as studies regarding ocular (eye) and visual system traumatic injury for the care and treatment of battle-injured casualties. In FY17 tis effort moves to project ET4. ***FY 2015 Accomplishments:*** : Down-selected and further developed drug delivery, diagnostic, tissue repair, and treatment strategies including drugs and stem cell therapies for eye trauma. Based on FY14 work, evaluated candidate strategies for burn and wound-healing bone and soft tissue repair and strategies to repair extremities, craniomaxillofacial, genital, and abdominal regions. ***FY 2016 Plans:*** Down-select and develop 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. Evaluate candidate strategies for burn injury, bone and soft tissue repair, and strategies to address injury to the extremities, face, genital, and abdominal regions. Perform 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. Will continue studies in animal models of improved life support technologies for treatment of single and multiple organ failure.			
Title: Traumatic Brain Injury (TBI) ***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 2015 Accomplishments:*** Continued to screen and evaluate drugs and other treatment strategies (including brain cooling), stem cell constructs, sleep enhancement, and nutraceuticals (products derived from food sources that provide extra health benefits) for treatment of TBI. ***FY 2016 Plans:*** Down-select candidate drugs and other treatment strategies for treatment of TBI. Characterize polytrauma (multiple trauma injuries)/TBI animal models to develop potential TBI drug treatments. Characterize 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.	1.955	2.192	1.959
Accomplishments/Planned Programs Subtotals	15.394	17.005	10.033

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C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
ET4: *Appl Resch in Clinical and Rehabilitative Medicine*	-	0.000	0.000	7.273	-	7.273	7.378	8.948	9.130	9.343	-	-

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 2015	FY 2016	FY 2017
Title: Clinical and Rehabilitative Medicine	-	-	7.273
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.			
FY 2017 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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.			
Accomplishments/Planned Programs Subtotals	-	-	7.273

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: PB 2017 Army												Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
FH2: *Force Health Protection - Applied Research*	-	5.856	5.278	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: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
Title: Millennium Cohort Research ***Description:*** This effort supports a long-term study of Warfighters that includes psychological, physical and spiritual 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 2015 Accomplishments:*** Evaluated the impact of child health on Family functioning and Service Member health outcomes and investigated the impact of the Family's response to deployment on the mental health of the deployed Warfighter. ***FY 2016 Plans:*** 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.	4.432	4.796	-
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 2015 Accomplishments:*** Developed models to assess endurance for military relevant tasks including algorithm development to predict musculoskeletal adaptations to fatigue. Expanded biomechanical (application of mechanical principles to living organism) performance modeling to incorporate relevant tasks, such as lifting and marksmanship that use the upper body and core. ***FY 2016 Plans:*** 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.	1.424	0.482	-
Accomplishments/Planned Programs Subtotals	5.856	5.278	-

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** FH2 / *Force Health Protection - Applied Research*

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: PB 2017 Army			Date: February 2016
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 2015	FY 2016	FY 2017 Base	FY 2017 OCO	FY 2017 Total	FY 2018	FY 2019	FY 2020	FY 2021	Cost To Complete	Total Cost
VB4: *System Biology And Network Science Technology*	-	4.680	5.282	1.918	-	1.918	2.001	2.010	2.049	2.091	-	-

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 projects efforts support 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. An 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 (Post-Traumatic Stress Disorder (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).

Efforts in this project support the Soldier Portfolio and the principal area of Systems Biology/Network Sciences.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2015	FY 2016	FY 2017
Title: Systems Biology	4.680	5.282	1.918
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			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
differentiate among molecular signatures (unique combinations of biological molecules corresponding to clinical conditions) of disease, and supports transition of research to clinical applications. Conduct applied research to identify and characterize (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. Current studies are addressing exposures to industrial chemicals, toxicogenomics (study of what genes are involved with responding to a toxic substance and those genes associated with susceptibility to the toxic substance) of metals, health surveillance with assessment of micro-biome, metabolomics of heat injury, and modeling toxicity pathways. The task funding for the toxic substances research effort moves to project 869 in FY17.			
FY 2015 Accomplishments: Designed and utilized new tools to solve problems that arise in the course of extracting signatures (distinctive and unique characteristics of a condition or event) related to suicide, coagulopathy and chronic pain in Warfighters. Evaluated and integrated computer modeling with high-content global molecular data sets from PTSD clinical studies and utilized PTSD animal models to further therapeutic studies / Followed the successful pattern of combining clinical trials with animal models, applied this to study coagulopathy and mechanisms of chronic pain. Developed and enhanced capabilities to support transition of research to advanced development by incorporating newly emerging digital Food and Drug Administration (FDA)-approved approaches. Evaluated high-content data sets from environmental exposures using computational platforms to identify biomarkers altered in physiological pathways and developed a panel of biomarkers to evaluate adverse reactions from exposure to environmental health hazards with a focus on toxicity markers of a specific organ system. Verified the pathway(s) (through tissues/cells) that a toxic substance exerts its effects and validated biomarkers of that effect in the rodent model.			
FY 2016 Plans: Improve and apply 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. Evaluate and model molecular data from PTSD clinical studies to further define signatures within PTSD sufferers into distinct subgroups. Further refine and establish PTSD diagnostic biomarkers, to improve therapeutic drug effectiveness and support therapeutic drug discovery. Use PTSD biomarker in animal models to verify new therapeutic drug targeting. Construct a laboratory developed test (LDT) for PTSD using commercial off-the-shelf technology, and evaluate it in selected medical treatment facilities; continue to advance tests for identification of subgroups of PTSD to aid in informing appropriate therapeutic approaches and pursue FDA approval. Begin 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:			

Exhibit R-2A, RDT&E Project Justification: PB 2017 Army		Date: February 2016
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 2015	FY 2016	FY 2017
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.			
Accomplishments/Planned Programs Subtotals	4.680	5.282	1.918

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A