Department of Defense
Fiscal Year (FY) 2016 President's Budget Submission

February 2015

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, $6,926,459,000.00 to remain available for obligation until September 30, 2017.

The following Justification Books were prepared at a cost of $1,187,353.84: 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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Department of Defense
FY 2016 President's Budget
Exhibit R-1 FY 2016 President's Budget
Total Obligational Authority
(Dollars in Thousands)

15 Jan 2015

Appropriation	FY 2014 (Base & OCO)	FY 2015 Base Enacted	FY 2015 OCO Enacted	FY 2015 Total Enacted	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Research, Development, Test & Eval, Army	7,124,298	6,673,146	2,000	6,675,146	6,924,959	1,500	6,926,459
Total Research, Development, Test & Evaluation	7,124,298	6,673,146	2,000	6,675,146	6,924,959	1,500	6,926,459

R-1C1: FY 2016 President's Budget (Published Version of PB Position), as of January 15, 2015 at 09:20:53

Department of Defense
FY 2016 President's Budget
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(Dollars in Thousands)

15 Jan 2015

Summary Recap of Budget Activities	FY 2014 (Base & OCO)	FY 2015 Base Enacted	FY 2015 OCO Enacted	FY 2015 Total Enacted	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Basic Research	425,321	460,268		460,268	425,079		425,079
Applied Research	930,900	981,421		981,421	879,685		879,685
Advanced Technology Development	1,044,919	1,113,149		1,113,149	895,747		895,747
Advanced Component Development & Prototypes	424,652	302,922	2,000	304,922	498,659	1,500	500,159
System Development & Demonstration	1,955,833	1,622,353		1,622,353	2,068,950		2,068,950
RDT&E Management Support	1,317,280	1,015,139		1,015,139	1,027,542		1,027,542
Operational Systems Development	1,025,393	1,177,894		1,177,894	1,129,297		1,129,297
Total Research, Development, Test & Evaluation	7,124,298	6,673,146	2,000	6,675,146	6,924,959	1,500	6,926,459

Summary Recap of FYDP Programs

	FY 2014 (Base & OCO)	FY 2015 Base Enacted	FY 2015 OCO Enacted	FY 2015 Total Enacted	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Strategic Forces	58,383						
General Purpose Forces	581,979	716,615		716,615	693,053		693,053
Intelligence and Communications	201,878	165,416		165,416	163,446		163,446
Research and Development	6,222,823	5,710,126	2,000	5,712,126	6,015,482	1,500	6,016,982
Central Supply and Maintenance	54,392	76,187		76,187	48,442		48,442
Administration and Associated Activities	126						
Classified Programs	4,717	4,802		4,802	4,536		4,536
Total Research, Development, Test & Evaluation	7,124,298	6,673,146	2,000	6,675,146	6,924,959	1,500	6,926,459

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Department of the Army
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Operational Systems Development	1,025,393	1,177,894		1,177,894	1,129,297		1,129,297
Total Research, Development, Test & Evaluation	7,124,298	6,673,146	2,000	6,675,146	6,924,959	1,500	6,926,459

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Research and Development	6,222,823	5,710,126	2,000	5,712,126	6,015,482	1,500	6,016,982
Central Supply and Maintenance	54,392	76,187		76,187	48,442	.	48,442
Administration and Associated Activities	126						
Classified Programs	4,717	4,802		4,802	4,536		4,536
Total Research, Development, Test & Evaluation	7,124,298	6,673,146	2,000	6,675,146	6,924,959	1,500	6,926,459

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Department of the Army
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Exhibit R-1 FY 2016 President's Budget
Total Obligational Authority
(Dollars in Thousands)

15 Jan 2015

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

Line No	Program Element Number	Item	Act	FY 2014 (Base & OCO)	FY 2015 Base Enacted	FY 2015 OCO Enacted	FY 2015 Total Enacted	FY 2016 Base	FY 2016 OCO	FY 2016 Total	Sec
1	0601101A	In-House Laboratory Independent Research	01	21,255	13,427		13,427	13,018		13,018	U
2	0601102A	Defense Research Sciences	01	216,774	248,283		248,283	239,118		239,118	U
3	0601103A	University Research Initiatives	01	76,682	89,776		89,776	72,603		72,603	U
4	0601104A	University and Industry Research Centers	01	110,610	108,782		108,782	100,340		100,340	U
		Basic Research		425,321	460,268		460,268	425,079		425,079	
5	0602105A	Materials Technology	02	45,243	46,000		46,000	28,314		28,314	U
6	0602120A	Sensors and Electronic Survivability	02	42,677	46,258		46,258	38,374		38,374	U
7	0602122A	TRACTOR HIP	02	35,493	16,358		16,358	6,879		6,879	U
8	0602211A	Aviation Technology	02	54,667	63,414		63,414	56,884		56,884	U
9	0602270A	Electronic Warfare Technology	02	17,464	18,500		18,500	19,243		19,243	U
10	0602303A	Missile Technology	02	58,426	62,180		62,180	45,053		45,053	U
11	0602307A	Advanced Weapons Technology	02	25,310	38,513		38,513	29,428		29,428	U
12	0602308A	Advanced Concepts and Simulation	02	23,364	27,423		27,423	27,862		27,862	U
13	0602601A	Combat Vehicle and Automotive Technology	02	63,476	72,861		72,861	68,839		68,839	U
14	0602618A	Ballistics Technology	02	73,906	85,575		85,575	92,801		92,801	U
15	0602622A	Chemical, Smoke and Equipment Defeating Technology	02	4,378	3,970		3,970	3,866		3,866	U
16	0602623A	Joint Service Small Arms Program	02	7,592	6,850		6,850	5,487		5,487	U
17	0602624A	Weapons and Munitions Technology	02	52,013	63,057		63,057	48,340		48,340	U
18	0602705A	Electronics and Electronic Devices	02	68,062	73,422		73,422	55,301		55,301	U

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19	0602709A	Night Vision Technology	02	42,624	44,935		44,935	33,807		33,807	U
20	0602712A	Countermine Systems	02	30,019	29,428		29,428	25,068		25,068	U
21	0602716A	Human Factors Engineering Technology	02	21,118	23,778		23,778	23,681		23,681	U
22	0602720A	Environmental Quality Technology	02	22,333	15,653		15,653	20,850		20,850	U
23	0602782A	Command, Control, Communications Technology	02	33,580	33,807		33,807	36,160		36,160	U
24	0602783A	Computer and Software Technology	02	10,232	10,761		10,761	12,656		12,656	U
25	0602784A	Military Engineering Technology	02	69,192	67,302		67,302	63,409		63,409	U
26	0602785A	Manpower/Personnel/Training Technology	02	17,395	23,288		23,288	24,735		24,735	U
27	0602786A	Warfighter Technology	02	30,950	32,044		32,044	35,795		35,795	U
28	0602787A	Medical Technology	02	81,386	76,044		76,044	76,853		76,853	U
		Applied Research		930,900	981,421		981,421	879,685		879,685	
29	0603001A	Warfighter Advanced Technology	03	64,337	78,109		78,109	46,973		46,973	U
30	0603002A	Medical Advanced Technology	03	100,646	106,264		106,264	69,584		69,584	U
31	0603003A	Aviation Advanced Technology	03	78,513	102,950		102,950	89,736		89,736	U
32	0603004A	Weapons and Munitions Advanced Technology	03	72,934	72,908		72,908	57,663		57,663	U
33	0603005A	Combat Vehicle and Automotive Advanced Technology	03	146,486	147,485		147,485	113,071		113,071	U
34	0603006A	Space Application Advanced Technology	03	10,706	6,880		6,880	5,554		5,554	U
35	0603007A	Manpower, Personnel and Training Advanced Technology	03	6,145	13,574		13,574	12,636		12,636	U

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36	0603008A	Electronic Warfare Advanced Technology	03	40,345	44,851		44,851				U
37	0603009A	TRACTOR HIKE	03	9,161	7,492		7,492	7,502		7,502	U
38	0603015A	Next Generation Training & Simulation Systems	03	13,168	16,740		16,740	17,425		17,425	U
39	0603020A	TRACTOR ROSE	03	10,662	14,483		14,483	11,912		11,912	U
40	0603125A	Combating Terrorism - Technology Development	03	14,546	24,257		24,257	27,520		27,520	U
41	0603130A	TRACTOR NAIL	03	3,192	3,440		3,440	2,381		2,381	U
42	0603131A	TRACTOR EGGS	03	2,366	2,406		2,406	2,431		2,431	U
43	0603270A	Electronic Warfare Technology	03	24,652	26,046		26,046	26,874		26,874	U
44	0603313A	Missile and Rocket Advanced Technology	03	81,951	79,934		79,934	49,449		49,449	U
45	0603322A	TRACTOR CAGE	03	11,857	11,105		11,105	10,999		10,999	U
46	0603461A	High Performance Computing Modernization Program	03	213,238	221,518		221,518	177,159		177,159	U
47	0603606A	Landmine Warfare and Barrier Advanced Technology	03	22,233	13,070		13,070	13,993		13,993	U
48	0603607A	Joint Service Small Arms Program	03	4,902	7,318		7,318	5,105		5,105	U
49	0603710A	Night Vision Advanced Technology	03	43,459	44,119		44,119	40,929		40,929	U
50	0603728A	Environmental Quality Technology Demonstrations	03	11,540	11,445		11,445	10,727		10,727	U
51	0603734A	Military Engineering Advanced Technology	03	23,838	17,606		17,606	20,145		20,145	U
52	0603772A	Advanced Tactical Computer Science and Sensor Technology	03	34,042	39,149		39,149	38,163		38,163	U

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53	0603794A	C3 Advanced Technology	03					37,816		37,816	U
		Advanced Technology Development		1,044,919	1,113,149		1,113,149	895,747		895,747	
54	0603305A	Army Missile Defense Systems Integration	04	23,117	25,795		25,795	10,347		10,347	U
55	0603308A	Army Space Systems Integration	04	13,448	13,996		13,996	25,061		25,061	U
56	0603619A	Landmine Warfare and Barrier - Adv Dev	04					49,636		49,636	U
57	0603627A	Smoke, Obscurant and Target Defeating Sys-Adv Dev	04					13,426		13,426	U
58	0603639A	Tank and Medium Caliber Ammunition	04	31,580	29,318		29,318	46,749		46,749	U
59	0603653A	Advanced Tank Armament System (ATAS)	04	54,259							U
60	0603747A	Soldier Support and Survivability	04	11,513	6,997	2,000	8,997	6,258	1,500	7,758	U
61	0603766A	Tactical Electronic Surveillance System - Adv Dev	04	10,390	8,953		8,953	13,472		13,472	U
62	0603774A	Night Vision Systems Advanced Development	04	8,760	3,050		3,050	7,292		7,292	U
63	0603779A	Environmental Quality Technology - Dem/Val	04	2,544	7,826		7,826	8,813		8,813	U
64	0603782A	Warfighter Information Network-Tactical - DEM/VAL	04	118,256							U
65	0603790A	NATO Research and Development	04	3,743	2,952		2,952	6,075		6,075	U
66	0603801A	Aviation - Adv Dev	04	4,848							U
67	0603804A	Logistics and Engineer Equipment - Adv Dev	04	11,623	13,380		13,380	21,233		21,233	U
68	0603807A	Medical Systems - Adv Dev	04	17,524	23,647		23,647	31,962		31,962	U

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69	0603827A	Soldier Systems - Advanced Development	04	13,844	6,828		6,828	22,194		22,194	U
70	0603850A	Integrated Broadcast Service	04	79							U
71	0604100A	Analysis Of Alternatives	04		9,910		9,910	9,805		9,805	U
72	0604115A	Technology Maturation Initiatives	04	10,741	44,214		44,214	40,917		40,917	U
73	0604120A	Assured Positioning, Navigation and Timing (PNT)	04	7,500	9,925		9,925	30,058		30,058	U
74	0604319A	Indirect Fire Protection Capability Increment 2-Intercept (IFPC2)	04	76,559	96,131		96,131	155,361		155,361	U
75	0604785A	Integrated Base Defense (Budget Activity 4)	04	4,324							U
		Advanced Component Development & Prototypes		424,652	302,922	2,000	304,922	498,659	1,500	500,159	
76	0604201A	Aircraft Avionics	05	64,396	41,236		41,236	12,939		12,939	U
77	0604220A	Armed, Deployable Helos	05	26,000							U
78	0604270A	Electronic Warfare Development	05	134,260	5,999		5,999	18,843		18,843	U
79	0604280A	Joint Tactical Radio	05	30,752	9,827		9,827	9,861		9,861	U
80	0604290A	Mid-tier Networking Vehicular Radio (MNVR)	05	22,553	9,725		9,725	8,763		8,763	U
81	0604321A	All Source Analysis System	05	4,837	5,532		5,532	4,309		4,309	U
82	0604328A	TRACTOR CAGE	05	28,229	19,929		19,929	15,138		15,138	U
83	0604601A	Infantry Support Weapons	05	82,332	34,575		34,575	74,128		74,128	U
84	0604604A	Medium Tactical Vehicles	05	2,068	210		210				U
85	0604611A	JAVELIN	05	4,471	4,164		4,164	3,945		3,945	U
86	0604622A	Family of Heavy Tactical Vehicles	05	23,944	12,906		12,906				U

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87	0604633A	Air Traffic Control	05	514	16,756		16,756	10,076		10,076	U
88	0604641A	Tactical Unmanned Ground Vehicle (TUGV)	05		2,769		2,769	40,374		40,374	U
89	0604710A	Night Vision Systems - Eng Dev	05	47,811	65,299		65,299	67,582		67,582	U
90	0604713A	Combat Feeding, Clothing, and Equipment	05	1,874	3,034		3,034	1,763		1,763	U
91	0604715A	Non-System Training Devices - Eng Dev	05	22,168	8,943		8,943	27,155		27,155	U
92	0604741A	Air Defense Command, Control and Intelligence - Eng Dev	05	38,412	15,898		15,898	24,569		24,569	U
93	0604742A	Constructive Simulation Systems Development	05	19,596	4,394		4,394	23,364		23,364	U
94	0604746A	Automatic Test Equipment Development	05	6,498	11,079		11,079	8,960		8,960	U
95	0604760A	Distributive Interactive Simulations (DIS) - Eng Dev	05	12,193	10,022		10,022	9,138		9,138	U
96	0604780A	Combined Arms Tactical Trainer (CATT) Core	05	26,720	34,712		34,712	21,622		21,622	U
97	0604798A	Brigade Analysis, Integration and Evaluation	05	91,427	85,246		85,246	99,242		99,242	U
98	0604802A	Weapons and Munitions - Eng Dev	05	16,770	14,998		14,998	21,379		21,379	U
99	0604804A	Logistics and Engineer Equipment - Eng Dev	05	43,497	24,566		24,566	48,339		48,339	U
100	0604805A	Command, Control, Communications Systems - Eng Dev	05	7,131	4,431		4,431	2,726		2,726	U
101	0604807A	Medical Materiel/Medical Biological Defense Equipment - Eng Dev	05	33,890	30,384		30,384	45,412		45,412	U
102	0604808A	Landmine Warfare/Barrier - Eng Dev	05	87,895	57,674		57,674	55,215		55,215	U

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103	0604814A	Artillery Munitions - EMD	05	6,352							U
104	0604818A	Army Tactical Command & Control Hardware & Software	05	22,900	29,675		29,675	163,643		163,643	U
105	0604820A	Radar Development	05	1,796	5,221		5,221	12,309		12,309	U
106	0604822A	General Fund Enterprise Business System (GFEBS)	05	3,218				15,700		15,700	U
107	0604823A	Firefinder	05	17,734	23,480		23,480	6,243		6,243	U
108	0604827A	Soldier Systems - Warrior Dem/Val	05	25,477	6,155		6,155	18,776		18,776	U
109	0604854A	Artillery Systems - EMD	05	117,241	1,911		1,911	1,953		1,953	U
110	0605013A	Information Technology Development	05	59,329	69,728		69,728	67,358		67,358	U
111	0605018A	Integrated Personnel and Pay System-Army (IPPS-A)	05	34,400	68,434		68,434	136,011		136,011	U
112	0605028A	Armored Multi-Purpose Vehicle (AMPV)	05	27,345	92,309		92,309	230,210		230,210	U
113	0605030A	Joint Tactical Network Center (JTNC)	05	65,849	8,436		8,436	13,357		13,357	U
114	0605031A	Joint Tactical Network (JTN)	05		17,989		17,989	18,055		18,055	U
115	0605032A	TRACTOR TIRE	05					5,677		5,677	U
116	0605035A	Common Infrared Countermeasures (CIRCM)	05		145,337		145,337	77,570		77,570	U
117	0605051A	Aircraft Survivability Development	05					18,112		18,112	U
118	0605350A	WIN-T Increment 3 - Full Networking	05		113,155		113,155	39,700		39,700	U
119	0605380A	AMF Joint Tactical Radio System (JTRS)	05	9,874	6,878		6,878	12,987		12,987	U
120	0605450A	Joint Air-to-Ground Missile (JAGM)	05	15,684	83,799		83,799	88,866		88,866	U
121	0605456A	PAC-3/MSE Missile	05	86,223	34,991		34,991	2,272		2,272	U

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

Line No	Program Element Number	Item	Act	FY 2014 (Base & OCO)	FY 2015 Base Enacted	FY 2015 OCO Enacted	FY 2015 Total Enacted	FY 2016 Base	FY 2016 OCO	FY 2016 Total	Sec
122	0605457A	Army Integrated Air and Missile Defense (AIAMD)	05	358,192	152,516		152,516	214,099		214,099	U
123	0605625A	Manned Ground Vehicle	05	96,820	49,134		49,134	49,247		49,247	U
124	0605626A	Aerial Common Sensor	05	10,377	17,748		17,748	2		2	U
125	0605766A	National Capabilities Integration (MIP)	05	21,132	15,212		15,212	10,599		10,599	U
126	0605812A	Joint Light Tactical Vehicle (JLTV) Engineering and Manufacturing Development Ph	05	81,388	45,694		45,694	32,486		32,486	U
127	0605830A	Aviation Ground Support Equipment	05		10,036		10,036	8,880		8,880	U
128	0210609A	Paladin Integrated Management (PIM)	05		80,263		80,263	152,288		152,288	U
129	0303032A	TROJAN - RH12	05	3,463	983		983	5,022		5,022	U
130	0304270A	Electronic Warfare Development	05	10,801	8,961		8,961	12,686		12,686	U
		System Development & Demonstration		1,955,833	1,622,353		1,622,353	2,068,950		2,068,950	
131	0604256A	Threat Simulator Development	06	23,598	22,057		22,057	20,035		20,035	U
132	0604258A	Target Systems Development	06	13,139	10,037		10,037	16,684		16,684	U
133	0604759A	Major T&E Investment	06	38,534	56,285		56,285	62,580		62,580	U
134	0605103A	Rand Arroyo Center	06	18,281	20,601		20,601	20,853		20,853	U
135	0605301A	Army Kwajalein Atoll	06	187,225	175,956		175,956	205,145		205,145	U
136	0605326A	Concepts Experimentation Program	06	21,563	19,430		19,430	19,430		19,430	U
137	0605502A	Small Business Innovative Research	06	182,958							U
138	0605601A	Army Test Ranges and Facilities	06	335,270	274,980		274,980	277,646		277,646	U
139	0605602A	Army Technical Test Instrumentation and Targets	06	63,944	45,573		45,573	51,550		51,550	U

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Department of the Army
FY 2016 President's Budget
Exhibit R-1 FY 2016 President's Budget
Total Obligational Authority
(Dollars in Thousands)

15 Jan 2015

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

Line No	Program Element Number	Item	Act	FY 2014 (Base & OCO)	FY 2015 Base Enacted	FY 2015 OCO Enacted	FY 2015 Total Enacted	FY 2016 Base	FY 2016 OCO	FY 2016 Total	Sec
140	0605604A	Survivability/Lethality Analysis	06	42,865	33,294		33,294	33,246		33,246	U
141	0605606A	Aircraft Certification	06	5,953	4,700		4,700	4,760		4,760	U
142	0605702A	Meteorological Support to RDT&E Activities	06	7,210	6,411		6,411	8,303		8,303	U
143	0605706A	Materiel Systems Analysis	06	19,694	20,744		20,744	20,403		20,403	U
144	0605709A	Exploitation of Foreign Items	06	7,125	7,015		7,015	10,396		10,396	U
145	0605712A	Support of Operational Testing	06	55,062	49,217		49,217	49,337		49,337	U
146	0605716A	Army Evaluation Center	06	64,425	55,031		55,031	52,694		52,694	U
147	0605718A	Army Modeling & Sim X-Cmd Collaboration & Integ	06	1,239	1,124		1,124	938		938	U
148	0605801A	Programwide Activities	06	81,013	64,160		64,160	60,319		60,319	U
149	0605803A	Technical Information Activities	06	33,018	32,303		32,303	28,478		28,478	U
150	0605805A	Munitions Standardization, Effectiveness and Safety	06	56,543	64,027		64,027	32,604		32,604	U
151	0605857A	Environmental Quality Technology Mgmt Support	06	5,019	2,611		2,611	3,186		3,186	U
152	0605898A	Management HQ - R&D	06	53,476	49,583		49,583	48,955		48,955	U
153	0909999A	Financing for Cancelled Account Adjustments	06	126							U
		RDT&E Management Support		1,317,280	1,015,139		1,015,139	1,027,542		1,027,542	
154	0603778A	MLRS Product Improvement Program	07	93,621	17,103		17,103	18,397		18,397	U
155	0603813A	TRACTOR PULL	07					9,461		9,461	U
156	0607131A	Weapons and Munitions Product Improvement Programs	07					4,945		4,945	U

Department of the Army
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Total Obligational Authority
(Dollars in Thousands)

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

Line No	Program Element Number	Item	Act	FY 2014 (Base & OCO)	FY 2015 Base Enacted	FY 2015 OCO Enacted	FY 2015 Total Enacted	FY 2016 Base	FY 2016 OCO	FY 2016 Total	Sec
157	0607133A	TRACTOR SMOKE	07					7,569		7,569	U
158	0607135A	Apache Product Improvement Program	07		86,099		86,099	69,862		69,862	U
159	0607136A	Blackhawk Product Improvement Program	07		48,446		48,446	66,653		66,653	U
160	0607137A	Chinook Product Improvement Program	07		35,424		35,424	37,407		37,407	U
161	0607138A	Fixed Wing Product Improvement Program	07		819		819	1,151		1,151	U
162	0607139A	Improved Turbine Engine Program	07		49,328		49,328	51,164		51,164	U
163	0607140A	Emerging Technologies from NIE	07		4,916		4,916	2,481		2,481	U
164	0607141A	Logistics Automation	07	3,592	3,652		3,652	1,673		1,673	U
165	0607664A	Biometric Enabling Capability (BEC)	07		1,332		1,332				U
166	0607665A	Family of Biometrics	07	7,160				13,237		13,237	U
167	0607865A	Patriot Product Improvement	07	33,935	57,962		57,962	105,816		105,816	U
168	0102419A	Aerostat Joint Project - EMD	07	58,383							U
169	0202429A	Aerostat Joint Project - COCOM Exercise	07	22,252	43,248		43,248	40,565		40,565	U
170	0203726A	Adv Field Artillery Tactical Data System	07	24,120	1,273		1,273				U
171	0203728A	Joint Automated Deep Operation Coordination System (JADOCS)	07		36,658		36,658	35,719		35,719	U
172	0203735A	Combat Vehicle Improvement Programs	07	171,543	297,850		297,850	257,167		257,167	U
173	0203740A	Maneuver Control System	07	35,337	45,065		45,065	15,445		15,445	U
174	0203744A	Aircraft Modifications/Product Improvement Programs	07	227,333							U

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

Line No	Program Element Number	Item	Act	FY 2014 (Base & OCO)	FY 2015 Base Enacted	FY 2015 OCO Enacted	FY 2015 Total Enacted	FY 2016 Base	FY 2016 OCO	FY 2016 Total	Sec
175	0203752A	Aircraft Engine Component Improvement Program	07	309	381		381	364		364	U
176	0203758A	Digitization	07	5,978	5,993		5,993	4,361		4,361	U
177	0203801A	Missile/Air Defense Product Improvement Program	07	1,830	5,112		5,112	3,154		3,154	U
178	0203802A	Other Missile Product Improvement Programs	07	60,005	38,323		38,323	35,951		35,951	U
179	0203808A	TRACTOR CARD	07	18,768	22,691		22,691	34,686		34,686	U
180	0205402A	Integrated Base Defense - Operational System Dev	07		4,362		4,362	10,750		10,750	U
181	0205410A	Materials Handling Equipment	07		834		834	402		402	U
182	0205412A	Environmental Quality Technology - Operational System Dev	07		280		280				U
183	0205456A	Lower Tier Air and Missile Defense (AMD) System	07		78,720		78,720	64,159		64,159	U
184	0205778A	Guided Multiple-Launch Rocket System (GMLRS)	07		45,353		45,353	17,527		17,527	U
185	0208053A	Joint Tactical Ground System	07	14,504	10,209		10,209	20,515		20,515	U
187	0303028A	Security and Intelligence Activities	07	7,596	12,518		12,518	12,368		12,368	U
188	0303140A	Information Systems Security Program	07	9,040	14,167		14,167	31,154		31,154	U
189	0303141A	Global Combat Support System	07	39,834	4,525		4,525	12,274		12,274	U
190	0303142A	SATCOM Ground Environment (SPACE)	07	17,644	11,006		11,006	9,355		9,355	U
191	0303150A	WWMCCS/Global Command and Control System	07	13,852	2,150		2,150	7,053		7,053	U
193	0305179A	Integrated Broadcast Service (IBS)	07					750		750	U

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Department of the Army
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Appropriation: 2040A Research, Development, Test & Eval, Army

Line No	Program Element Number	Item	Act	FY 2014 (Base & OCO)	FY 2015 Base Enacted	FY 2015 OCO Enacted	FY 2015 Total Enacted	FY 2016 Base	FY 2016 OCO	FY 2016 Total	Sec
194	0305204A	Tactical Unmanned Aerial Vehicles	07	33,515	22,870		22,870	13,225		13,225	U
195	0305206A	Airborne Reconnaissance Systems	07					22,870		22,870	U
196	0305208A	Distributed Common Ground/Surface Systems	07	27,607	20,155		20,155	25,592		25,592	U
197	0305219A	MQ-1C Gray Eagle UAS	07	13,074	46,472		46,472				U
198	0305232A	RQ-11 UAV	07	5,984							U
199	0305233A	RQ-7 UAV	07	12,025	16,389		16,389	7,297		7,297	U
200	0307665A	Biometrics Enabled Intelligence	07	7,443	1,973		1,973				U
201	0310349A	Win-T Increment 2 - Initial Networking	07		3,247		3,247	3,800		3,800	U
202	0708045A	End Item Industrial Preparedness Activities	07	54,392	76,187		76,187	48,442		48,442	U
9999	9999999999	Classified Programs		4,717	4,802		4,802	4,536		4,536	U
		Operational Systems Development		1,025,393	1,177,894		1,177,894	1,129,297		1,129,297	
		Total Research, Development, Test & Eval, Army		7,124,298	6,673,146	2,000	6,675,146	6,924,959	1,500	6,926,459	

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Budget Activity 02: Applied Research
Appropriation 2040: Research, Development, Test & Evaluation, Army

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Program Element Table of Contents (Alphabetically by Program Element Title)

Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army											Date: February 2015	

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

R-1 Program Element (Number/Name)
PE 0602105A *I Materials Technology*

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
Total Program Element	-	45.243	46.000	28.314	-	28.314	30.295	30.696	31.391	32.006	-	-
H7B: *Advanced Materials Initiatives (CA)*	-	19.000	18.000	-	-	-	-	-	-	-	-	-
H7G: *Nanomaterials Applied Research*	-	3.887	3.324	3.674	-	3.674	5.454	5.357	5.845	5.962	-	-
H84: *Materials*	-	22.356	24.676	24.640	-	24.640	24.841	25.339	25.546	26.044	-	-

Note

 FY14 Congressional add for Silicon Carbide research reprogrammed to 0602705A for proper execution.

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 U.S. 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 2016 Army			Date: February 2015	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*		**R-1 Program Element (Number/Name)** PE 0602105A *I Materials Technology*		

B. Program Change Summary ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Previous President's Budget	55.569	28.006	28.481	-	28.481
Current President's Budget	45.243	46.000	28.314	-	28.314
Total Adjustments	-10.326	17.994	-0.167	-	-0.167
• Congressional General Reductions	-	-0.006			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	18.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-10.000	-			
• SBIR/STTR Transfer	-0.326	-			
• Adjustments to Budget Years	-	-	-0.167	-	-0.167

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

	FY 2014	FY 2015
Project: H7B: *Advanced Materials Initiatives (CA)*		
Congressional Add: *Nanotechnology Research*	4.000	-
Congressional Add: *Materials Research*	15.000	-
Congressional Add: *Program Increase*	-	18.000
Congressional Add Subtotals for Project: H7B	19.000	18.000
Congressional Add Totals for all Projects	19.000	18.000

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army											**Date:** February 2015	
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602105A *I Materials Technology*					**Project (Number/Name)** H7B *I Advanced Materials Initiatives (CA)*			
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
H7B: *Advanced Materials Initiatives (CA)*	-	19.000	18.000	-	-	-	-	-	-	-	-	-

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 2014**	**FY 2015**
Congressional Add: Nanotechnology Research	4.000	-
FY 2014 Accomplishments: This is a Congressional Interest Item. Designed an adaptation of methodology and processes that creates the foundation for environmentally controlled facilities for computer processing and consolidation of large nano-material products using nano-structured aluminum and copper alloys. Developed adaptive and production scalable methodology to enable rapid processing of nano-coating, stable bulk nano-perform and stable near-net-shape components.		
Congressional Add: Materials Research	15.000	-
FY 2014 Accomplishments: This is a Congressional Interest Item. Designed a multi-scale modeling capability for bulk material and component modeling; established magneto-thermodynamics and other mathematical expressions describing fundamental laws in paramagnetic, diamagnetic, and ferromagnetic matter to further discover non-equilibrium, metastable, transformational, and otherwise currently non-existent matter and apply them to manufacturing science, modeling, and simulation innovations.		
Congressional Add: Program Increase	-	18.000
FY 2015 Plans: Program increase for materials research		
Congressional Adds Subtotals	19.000	18.000

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

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602105A *I Materials Technology*	**Project (Number/Name)** H7B *I Advanced Materials Initiatives (CA)*

D. Acquisition Strategy

 N/A

E. Performance Metrics

 N/A

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army										**Date:** February 2015	
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602105A *I Materials Technology*					**Project (Number/Name)** H7G *I Nanomaterials Applied Research*		
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
H7G: *Nanomaterials Applied Research*	-	3.887	3.324	3.674	-	3.674	5.454	5.357	5.845	5.962	-	-

Note
 Not applicable for this item.

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Title: Nanomaterials Applied Research	3.887	3.324	3.674
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 2014 Accomplishments:			

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602105A *I Materials Technology*	**Project (Number/Name)** H7G *I Nanomaterials Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Developed quantum dot-based optical taggant system to enable daylight visible tag, track, and locate (TTL) and combat identification capabilities; validated hydrophobic and antimicrobial coating technology on fabrics; and validated high rate response of nanometallic aluminum alloys for use in lightweight protection systems. *FY 2015 Plans:* Develop new materials capable of selective energy absorption based on novel coating technologies using nano- and microparticles; synthesize unique molecules for use as additives in transparent eye protection materials that simultaneously solve processing issues and enhance material performance; and demonstrate 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:* Will 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.			
Accomplishments/Planned Programs Subtotals	3.887	3.324	3.674

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 2016 Army										**Date:** February 2015	
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 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
H84: *Materials*	-	22.356	24.676	24.640	-	24.640	24.841	25.339	25.546	26.044	-	-

Note
Not applicable for this item.

A. Mission Description and Budget Item Justification

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

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

Work in this project makes extensive use of high performance computing and experimental validation and builds on research transitioned from PE 0601102A (Defense Research Sciences), project H42 (Materials and Mechanics), and project H43 (Ballistics). The work complements and is fully coordinated with efforts in 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 U.S. Army Research Laboratory (ARL) at Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Title: Structural Armor Materials	2.460	5.412	5.289
Description: Conduct applied research to design and evaluate lightweight armor materials and structures, investigate novel processing methodologies for cost effective manufacturing, and use existing and emerging modeling and simulation tools to enable formulation of lightweight, frontal, and structural armor materials for current and future platform applications. *FY 2014 Accomplishments:* Determined relationships between electronic signals from non-destructive characterization tools and microscopically observed structural details in ceramic armor materials; developed analysis algorithms used for modeling, process feedback and ballistic characteristics; developed aluminum alloys for blast and penetration resistance, emphasizing full scale fabrication for alloy			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
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 2014	FY 2015	FY 2016
chemistries optimized for the most beneficial metallurgical, mechanical and formability characteristics; and developed novel processing strategies for polymer compositions to enable tunable mechanical response; and applied processing science, modeling, and simulation to validate processing technology for the metallic encapsulation of ceramic armor tiles. *FY 2015 Plans:* Develop improved delamination resistance and damage tolerance of thick composites using innovative, cost-effective manufacturing concepts; demonstrate 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; develop validated physics-based models for fatigue of Mg alloy structures for lightweight vehicles that eliminate traditional empirical modeling approaches; and validate 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:* Will 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.			
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 2014 Accomplishments:* Developed synthesis and processing routes for low density boron-based ceramic compositions, provided model validation using high resolution electron microscopy; developed soft polymers through computational methods and experimental validation to match the rate dependent response of relevant human tissues; developed a robust fiber ballistic modeling tool to investigate penetration resistance of up to 10 layers of 2D fabric with multiple fiber or material architectures and validated the model with ballistic testing; developed a refined process model to describe the deformation characteristics and fiber-matrix adhesion; and provided experimental validation of the model. *FY 2015 Plans:*	5.339	5.402	5.348

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
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 2014	FY 2015	FY 2016
Develop a filament-level 3D textile model for use in the development of soft body armor; develop and characterize new materials for extremity armor; and develop 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:* Will 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 ultra high molecular weight polyethylene (UHMWPE) composites as a function of process history to enable improvements in material properties through process optimization.			
Title: Lethality Materials Technology (formerly named Composites) *Description:* For FY15, this effort formerly known as Composites is being renamed Lethality Materials Technology to more accurately describe the research being conducted. 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 2014 Accomplishments:* Validated improved multi-hit ballistic capability of three-dimensional, through-thickness reinforced (3D-TTR) hybridized composite test coupons; through the use of computational and experimental methods, designed and prepared polymer resins derived from renewable sources that provide properties at least equivalent to conventionally prepared polyether ether ketone (PEEK); and developed materials models and experimental techniques to validate >50% improvement in the adhesion of dissimilar materials used in vehicle protection platforms. *FY 2015 Plans:* Develop metal matrix composites to meet thermal requirements of gun barrels at reduced weight; utilize 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 explore interfacial/bonding effects on the coupled and high loading rate failure modes in thermoplastic composites. *FY 2016 Plans:* Will 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.	2.900	4.494	4.483
Title: Multifunctional Armor Materials	9.872	7.458	7.554

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602105A *I Materials Technology*	**Project (Number/Name)** H84 *I Materials*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Description: This effort researches novel multifunctional armor materials for Army applications such as structural energy storage, armor embedded command, control and communications (C3) antennas, and self healing materials. Soldier personnel protection materials transition to PE 0602786A/project H98. Reactive armor and electromagnetic armor materials transition to PE 0602618A/ project H80 and PE 0602601A/project C05. *FY 2014 Accomplishments:* Researched comprehensive armor materials technologies which include multifunctional batteries and/or capacitors (combined structural armor/power storage materials); supported total armor materials development via formulation of chemical agent resistive coatings (CARC) to reduce corrosion, improve decontamination, and lessen solar loading; assessed non-local theory and numerical methods for the failure of complex materials subjected to strong electromagnetic fields and validated with experiments; and determined synthetic viability of novel third generation chromophores for use in thick polymer laser protective materials. *FY 2015 Plans:* Validate new embedded power and enhanced survivability capabilities in multifunctional composite materials using enhanced modeling and processing techniques; develop new additive manufacturing capabilities using three dimensional (3-D) printing, cold spray, and/or related techniques to explore methods for low-volume production and expand design space (e.g., bio-inspired protection concepts); establish electric field effects on select ceramics and metals to enable Electric Field Assisted Sintering (EFAS) of new multifunctional materials; and identify inelastic deformation mechanisms as a function of strain rate in silicon carbide armor ceramics through development of novel experimental techniques. *FY 2016 Plans:* Will 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; evaluate 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.			
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 2014 Accomplishments:* Developed thermally stable, dispersible nanocrystalline cellulose for use in transparent materials to improve the stiffness by 25% without optical penalty; developed powder production technology for reliable, cost effective production of domestic	1.785	1.910	1.966

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
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 2014	FY 2015	FY 2016
nanocrystalline tungsten; identified tungsten carbide microstructures and properties for rigid body penetration of armor; and developed environmentally friendly binder materials for tungsten carbide. *FY 2015 Plans:* Develop thermally stable nanocrystalline cellulous particles and networks for incorporation into impact resistant transparent polymers used for personnel protection; establish bulk mechanical properties of thermally stabilized nanocrystalline alloys to expand design space for structural and armor applications; and synthesize novel third generation chromophores and incorporate into thick polymer materials used in anti-laser sensor protection devices. *FY 2016 Plans:* Will 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.			
Accomplishments/Planned Programs Subtotals	22.356	24.676	24.640

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 2016 Army											Date: February 2015	

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

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
Total Program Element	-	42.677	46.258	38.374	-	38.374	38.448	35.826	35.200	35.889	-	-
H15: *Ground Combat Id Tech*	-	2.287	-	-	-	-	-	-	-	-	-	-
H16: *S3I Technology*	-	20.720	17.936	21.168	-	21.168	21.438	17.964	18.057	18.405	-	-
SA1: *Sensors and Electronic Initiatives (CA)*	-	-	12.750	-	-	-	-	-	-	-	-	-
SA2: *Biotechnology Applied Research*	-	3.915	2.859	2.972	-	2.972	1.861	2.180	2.105	2.147	-	-
TS1: *Tactical Space Research*	-	5.378	4.775	5.808	-	5.808	6.702	7.026	7.072	7.213	-	-
TS2: *Robotics Technology*	-	10.377	7.938	8.426	-	8.426	8.447	8.656	7.966	8.124	-	-

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 program element (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

Exhibit R-2, **RDT&E Budget Item Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602120A *I Sensors and Electronic Survivability*	

Work is performed by the U.S. 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.

B. Program Change Summary ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**
Previous President's Budget	43.148	33.515	38.631	-	38.631
Current President's Budget	42.677	46.258	38.374	-	38.374
Total Adjustments	-0.471	12.743	-0.257	-	-0.257
• Congressional General Reductions	-	-0.007			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	12.750			
• Congressional Directed Transfers	-	-			
• Reprogrammings	0.250	-			
• SBIR/STTR Transfer	-0.721	-			
• Adjustments to Budget Years	-	-	-0.257	-	-0.257

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2014**	**FY 2015**
Project: SA1: *Sensors and Electronic Initiatives (CA)*		
Congressional Add: *Force Protection Radar Development*	-	5.000
Congressional Add: *Cyberspace security*	-	7.750
Congressional Add Subtotals for Project: SA1	-	12.750
Congressional Add Totals for all Projects	-	12.750

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army											Date: February 2015	
Appropriation/Budget Activity 2040 I 2				R-1 Program Element (Number/Name) PE 0602120A I Sensors and Electronic Survivability							Project (Number/Name) H15 I Ground Combat Id Tech	

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
H15: *Ground Combat Id Tech*	-	2.287	-	-	-	-	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

This project conducts applied research and investigates emergent techniques, devices and software for combat identification (CID) of Joint, allied, and coalition forces, including air-to-ground and ground-to-ground for mounted, dismounted, forward observer, and forward air controller missions. Efforts include research to enable a common battlespace picture for Joint and coalition situation awareness and fusion efforts to increase the survivability and lethality of coalition forces by fusing battlefield sensor and situational awareness data to identify friend from foe.

This project supports Army science and technology efforts in the Command, Control, Communications and Intelligence, Soldier and Ground Maneuver portfolios. Efforts in this project are complimentary of PE 0602270A (EW Techniques), PE 0603270A (EW 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 Communications-Electronics Research, Development, and Engineering Center (CERDEC), Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Combat Identification (CID) Technologies	2.287	-	-
Description: This effort evaluates and enhances CID modeling and simulation tools, concepts, and algorithms to improve anti-fratricide and combatant/non-combatant identification capabilities. Soldier-to-Soldier CID algorithms that interoperate with non-traditional CID sensors (air and ground) are developed to increase situational awareness (SA), feed the common operating picture, and increase the combat effectiveness of Soldier and Brigade Combat Teams (BCTs). Work being accomplished under PE 0603270A/project K16 complements this effort. *FY 2014 Accomplishments:* Designed and integrated tactical and commercial communications, wireless personal area networks and position location beaconing for a Soldier-to-Soldier CID capability utilizing equipment that is already employed by Soldiers; designed CID display and training tools to implement on existing mobile and handheld platforms being targeted by applicable programs of record.			
Accomplishments/Planned Programs Subtotals	2.287	-	-

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors and Electronic Survivability*	**Project (Number/Name)** H15 / *Ground Combat Id Tech*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

 N/A

E. Performance Metrics

 N/A

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army										Date: February 2015	

Appropriation/Budget Activity 2040 I 2				R-1 Program Element (Number/Name) PE 0602120A I *Sensors and Electronic Survivability*						Project (Number/Name) H16 I *S3I Technology*	

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
H16: *S3I Technology*	-	20.720	17.936	21.168	-	21.168	21.438	17.964	18.057	18.405	-	-

Note
 Not applicable for this item.

A. Mission Description and Budget Item Justification

 This project designs, investigates, and evaluates advanced sensor components, signal processing, and information fusion algorithms that will provide the future Soldier decisive new capabilities to locate, identify, decide 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 of 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, 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), 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 U.S. Army Research Laboratory (ARL), Adelphi, MD.

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602120A *I Sensors and Electronic Survivability*	**Project (Number/Name)** H16 *I S3I Technology*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Title: Non-Imaging Intelligence, Surveillance, and Reconnaissance (ISR) Sensing	5.317	5.539	5.435
Description: This effort evaluates and designs 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, E-field, and passive radio frequency (RF) with unique capabilities for Army & DoD applications such as technologies that enable detection of underground facilities. *FY 2014 Accomplishments:* Evaluated combination of collocated passive IR sensors to discriminate humans from animals with high confidence; investigated new algorithms to detect digging using seismic and magnetic sensors; and developed and evaluated algorithms to fuse input from acoustic velocity sensors, electric-field charge detectors, burn-product sensors, and infrared flash detectors to improve detection and classification of hostile threats such as gunfire, mortars, and rockets. *FY 2015 Plans:* Exploit multimodal sensing, fusion, and sensor processing to detect and locate diverse threats using static and mobile sensors and networked systems; enhance sensors and algorithms to provide persistent surveillance and actionable information; and exploit target features and mitigate environmental interference to enhance intelligence, surveillance, and reconnaissance (ISR) capabilities. *FY 2016 Plans:* Will develop advanced acoustic, magnetic- and e-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.			
Title: Networked Sensing and Data Fusion	5.748	4.843	5.474
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) multimodal 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 multimodal 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).			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602120A *I Sensors and Electronic Survivability*	**Project (Number/Name)** H16 *I S3I Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
FY 2014 Accomplishments: Developed pattern of life algorithms and statistics to discriminate between potential threat activities and normal behavior; developed and evaluated fusion algorithms that correlates bearing information from multiple soldier-worn gunfire detection systems for localization of shooter with reduced errors and uncertainties; developed protocols and message formats to enable interoperability between disparate sensor systems; developed tools to understand value and quality of information based on data discovery, collection, and fusion of large data sets; evaluated fusion of acoustic and electric field sensing systems to enable passive ranging of near-miss bullets based on wave propagation velocity differences; and developed passive electromagnetic (EM) target detection and localization using multi-axis electric field and magnetic field sensors. *FY 2015 Plans:* Implement anomaly detection algorithms by fusing the output of social network with disparate multimodal sensors to determine patterns of behavior; enhance 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 unmanned aerial systems (UAS); and mitigate background noise resulting from mobile sensor systems in complex environments. *FY 2016 Plans:* Will 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; develop algorithms that will exploit electric and magnetic field sensor fusion for electrical power event monitoring; and develop detection, tracking and cueing methodologies for counter-unmanned aerial system (C-UAS) using fusion of acoustic, passive RF, and imaging modalities.			
Title: Tagging Tracking and Locating (TTL) *Description:* Conduct applied research to support advances in state-of-the-art clandestine TTL for non-traditional hostile forces and non-cooperative targets. Specific technical details related to this effort are classified. *FY 2014 Accomplishments:* Investigated battery-free tags for extending the operating life of tags; and developed and extracted signals from targets of interest using mechanical and electromechanical coupling methods combined with applicable sensing modalities.	2.081	-	-
Title: Ultra Wideband (UWB) Radar *Description:* Conduct research to examine the technical underpinnings of UWB radar for several key Army concealed target detection technology requirements including landmine and improvised explosive device (IED) detection, sensing through-the-wall (STTW), and obstacle detection. Use 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.	2.369	2.913	2.892

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 *I* 2	R-1 Program Element (Number/Name) PE 0602120A *I Sensors and Electronic Survivability*	Project (Number/Name) H16 *I S3I Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
FY 2014 Accomplishments: Developed techniques for combining UWB radar with complementary sensors, such as video and thermal IR, for improving the probability of detection and confirmation of targets; and investigated computational electromagnetic models of the radar signature of RF devices placed in a complex building environment. *FY 2015 Plans:* Assess performance of UWB radar with complementary sensor techniques and technologies and compare to the current target detection capabilities and performance metrics; and investigate computational electromagnetic models to address new target deployments. *FY 2016 Plans:* Will investigate utility of combining forward looking radar with EO/IR sensor to improve detection and reduce false alarms for standoff detection of explosive hazards; incorporate stereo visible cameras to provide three-dimensional 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.			
Title: Networked Compact Radar, Wide Bandgap Optoelectronics, and Laser Protection Technologies *Description:* Investigate 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 (ID), and target acquisition/ tracking. Research semiconductor-based ultraviolet (UV) optoelectronics for communications, water/air/surface purification, and detection and identification of biological threats. Research novel materials and high speed switching technology for sensor and eye protection. *FY 2014 Accomplishments:* Created software and hardware architectures that enable compact radars to network with other unattended ground sensors for small unit force protection; evaluated nonlinear optical materials and tuned their properties to optimize performance of the overall vision protection system; and grew and characterized gallium nitride materials for extending the spectral range of UV lasers, light emitting diodes (LEDs), and detectors to wavelengths of 230 to 365 nanometers for enabling communications, water/air/surface purification, detection and identification of biological threats, and electro-optic countermeasures. *FY 2015 Plans:* Grow and characterize wide bandgap semiconductor materials and develop device designs to extend the spectral range of UV lasers, LEDs, and detectors to wavelengths from 200 to 365 nanometers to enable water/air/surface purification and the detection	2.433	3.083	3.854

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army			Date: February 2015		
Appropriation/Budget Activity 2040 *I* 2		**R-1 Program Element (Number/Name)** PE 0602120A *I Sensors and Electronic Survivability*		**Project (Number/Name)** H16 *I S3I Technology*	

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
and identification of biological threats; investigate different materials and evaluate solutions for eye and sensor protection against ultra-short pulses and near-IR high power threats. *FY 2016 Plans:* Will study and characterize non-linear optical materials (including two novel platinum bipyridine complexes and several iridium dimes) 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.			
Title: Adaptive Information Collection and Fusion *Description:* This effort develops network and processing infrastructure concepts, and validates algorithms to enable assets to dynamically modify their physical and information producing behaviors to adaptively operate within the dynamics and timelines of small unit decision makers. *FY 2014 Accomplishments:* Evaluated decision-adaptive anomaly detection techniques as a means of filtering data at the sensor level to improve situational understanding for small unit decision makers and evaluate the impact of these techniques on data latency and situational awareness; integrated these filtering algorithms into an autonomous collaborative collection framework and assessed the impact on delay and situation awareness.	2.772	-	-
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 technology to determine their impact on the performance of air defense radar technology. Electromagnetic modeling, RF measurements and experiments will be used to mitigate the effects of spoofing, jamming and signature management technology. This will include research extending from electronic devices, subassembly design, and laboratory prototypes to advance the state-of-the-art of air defense technology operating in contested environments. *FY 2015 Plans:* Investigate current and emerging technologies, across a broad RF spectrum, which may limit the performance of current air defense radar systems; modify existing physics-based electromagnetic modeling techniques to assess performance and identify critical areas of research; and examine performance in contested environments and research techniques to mitigate performance limitations. *FY 2016 Plans:*	-	1.558	3.513

UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army				Date: February 2015		

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 2014	FY 2015	FY 2016
Will 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.			
Accomplishments/Planned Programs Subtotals	20.720	17.936	21.168

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 2016 Army											**Date:** February 2015	
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602120A *I Sensors and Electronic Survivability*					**Project (Number/Name)** SA1 *I Sensors and Electronic Initiatives (CA)*			
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
SA1: *Sensors and Electronic Initiatives (CA)*	-	-	12.750	-	-	-	-	-	-	-	-	-

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 2014**	**FY 2015**
Congressional Add: Force Protection Radar Development	-	5.000
FY 2015 Plans: Congressional interest item for Force Protection Radar Development		
Congressional Add: Cyberspace security	-	7.750
FY 2015 Plans: Congressional interest funding for cyberspace security research		
Congressional Adds Subtotals	**-**	**12.750**

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 2016 Army											Date: February 2015	
Appropriation/Budget Activity 2040 *I* 2					**R-1 Program Element (Number/Name)** PE 0602120A *I Sensors and Electronic Survivability*					**Project (Number/Name)** SA2 *I Biotechnology Applied Research*		
COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
SA2: *Biotechnology Applied Research*	-	3.915	2.859	2.972	-	2.972	1.861	2.180	2.105	2.147	-	-

Note
Not applicable for this item.

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 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, DNA research and development, 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 U.S. Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Biotechnology Applied Research **Description:** This effort exploits breakthroughs in biotechnology basic research invented at the ICB to enable capabilities in sensors, electronics, photonics, and network science. ***FY 2014 Accomplishments:*** Improved biofuel cell electrode and membrane materials design, and validated for powering unattended ground sensors and other monitoring systems; completed and validated bio-inspired algorithms for control of swarms of micro-unmanned aerial vehicles; evaluated the use of a virus to template electrode materials to design improved batteries for small-scale, unmanned	3.915	2.859	2.972

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 I 2	R-1 Program Element (Number/Name) PE 0602120A I *Sensors and Electronic Survivability*	Project (Number/Name) SA2 I *Biotechnology Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
aerial vehicles; and evaluated protein capture agents and synthetic bio-molecules as materials to improve stability, affinity for overall environmental tolerance. *FY 2015 Plans:* Investigate performance limits of hybrid biofuel cells for powering unattended ground sensors or other remote, stand-alone monitoring systems; study interface technologies for small-scale batteries using virus templated materials for use on unmanned aerial vehicles (UAVs); and develop and study rapid bio-based screening, selection, and production processes for recognition and targeting of emerging threats to the Soldier. *FY 2016 Plans:* Will test hybrid biofuel cells; develop and test assays with advanced protein capture agents in order to validate capability to rapidly respond to emerging threats; and 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.			
Accomplishments/Planned Programs Subtotals	3.915	2.859	2.972

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 2016 Army											Date: February 2015	

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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
TS1: Tactical Space Research	-	5.378	4.775	5.808	-	5.808	6.702	7.026	7.072	7.213	-	-

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 DoD space science and technology applications to support Army space force enhancement and cooperative satellite payload development.

Work in this project complements and is fully coordinated with PE 0603006A (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 US Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT) in Huntsville, AL.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Tactical Space Research	4.349	3.765	4.787

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).

FY 2014 Accomplishments:
Designed and developed tracking system and antenna pointing component technologies for small satellites; developed orbit planning and analysis tools to support small satellite constellation concept of operation feasibility studies; researched and developed propulsion concepts for small satellite station keeping and maneuvering.

FY 2015 Plans:
Develop payload deployer subsystem for affordable launch vehicle; design and develop advanced attitude determination and control and propulsion subsystems for nanosatellites to change orbits in flight.

FY 2016 Plans:
Will 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

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602120A *I Sensors and Electronic Survivability*	**Project (Number/Name)** TS1 *I Tactical Space Research*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
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.			
Title: Space and Analysis Lab	1.029	1.010	1.021
Description: This effort provides an in-house capability to design and conduct analytic evaluations of space and high altitude technologies. *FY 2014 Accomplishments:* Designed and implemented a communications satellite testbed to conduct and evaluate nanosatellite assembly, payload integration, ground testing and preflight checkout; improved ground station capabilities within the lab to support on-orbit communications and imagery nanosatellite demonstrations. *FY 2015 Plans:* Validate 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:* Will develop components for follow-on small satellite designs, to include propulsion and distributed aperture imager components.			
Accomplishments/Planned Programs Subtotals	5.378	4.775	5.808

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 2016 Army										Date: February 2015	

Appropriation/Budget Activity 2040 *I* 2				R-1 Program Element (Number/Name) PE 0602120A *I Sensors and Electronic Survivability*				Project (Number/Name) TS2 *I Robotics Technology*			

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
TS2: *Robotics Technology*	-	10.377	7.938	8.426	-	8.426	8.447	8.656	7.966	8.124	-	-

Note
 Not applicable for this item.

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 mobility, intelligent vehicle control and behaviors, human-robot interaction, robotic manipulation, and improved mobility for unmanned vehicles of scales from micro-systems through tactical 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 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 U.S. 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 2014	FY 2015	FY 2016
Title: Robotics CTA	4.654	3.573	3.790
Description: Conduct applied research to provide essential capabilities for advanced perception, intelligent control and tactical behavior, human-robot interaction, robotic manipulation, and unique mobility for unmanned systems to conduct multiple military missions for a full range of robots from man-portable to larger systems. Research focuses on new sensor and sensor processing algorithms for rapid detection and classification of objects in cluttered and unknown environments, enabling autonomous mobility and intelligent tactical behavior by future unmanned systems; implementing adaptive control strategies that will enable unmanned systems to display intelligent tactical behavior, formulation of control strategies that will facilitate use of unmanned systems in			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602120A *I Sensors and Electronic Survivability*	**Project (Number/Name)** TS2 *I Robotics Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
populated environments and minimize the cognitive workload on Soldier operators enabling more dexterous manipulation of objects. *FY 2014 Accomplishments:* Continued to design perception and intelligence algorithms that permits unmanned systems to team with soldiers in moderately complex environments and conduct missions; instantiated learning algorithms to enable robots to continually learn from experience and recognize intent of other agents; focused on the implementation of hybrid cognitive/metric architecture to minimize the workload placed upon soldier, including the implementation of non-traditional control techniques; and implemented concepts for manipulation of objects and improved ground mobility for complex and constrained environments. *FY 2015 Plans:* Incorporate perception and intelligence algorithms into effective teaming of humans and robots as part of a mixed team to successfully conduct missions; conduct technology assessments of components and integrated systems to determine performance and technology maturity levels; and implement 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:* Will 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.			
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 2014 Accomplishments:* Implemented algorithms for perception of the local environment employing a hybrid cognitive/metric architecture; incorporated advanced algorithms for whole body manipulation on to test bed platforms; and implemented novel approaches to mobility in complex and constrained environments; and assessed performance of algorithms in an integrated context. *FY 2015 Plans:*	5.723	4.365	4.636

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
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 2014	FY 2015	FY 2016
Develop the perceptual and reasoning capabilities necessary to enable an unmanned system to deduce the intent of actions/activity; and explore and implement 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:* Will 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 as communication with human teammates; and conduct experiments focused upon establishing technology maturity and performance gaps.			
Accomplishments/Planned Programs Subtotals	10.377	7.938	8.426

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 2016 Army										Date: February 2015	

Appropriation/Budget Activity 2040: Research, Development, Test & Evaluation, Army I BA 2: Applied Research					R-1 Program Element (Number/Name) PE 0602122A I TRACTOR HIP						

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
Total Program Element	-	35.493	16.358	6.879	-	6.879	6.995	7.120	7.164	7.306	-	-
622: D622	-	2.438	2.218	2.396	-	2.396	2.275	2.315	2.329	2.375	-	-
B72: AB72	-	27.055	14.140	4.483	-	4.483	4.720	4.805	4.835	4.931	-	-
B73: AB73	-	6.000	-	-	-	-	-	-	-	-	-	-

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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Previous President's Budget	36.273	16.358	6.929	-	6.929
Current President's Budget	35.493	16.358	6.879	-	6.879
Total Adjustments	-0.780	-	-0.050	-	-0.050
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.780	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	-0.050	-	-0.050

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army										Date: February 2015	
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 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
622: _D622_	-	2.438	2.218	2.396	-	2.396	2.275	2.315	2.329	2.375	-	-

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 2016 Army										**Date:** February 2015	
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 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
B72: *AB72*	-	27.055	14.140	4.483	-	4.483	4.720	4.805	4.835	4.931	-	-

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 2016 Army											**Date:** February 2015	
Appropriation/Budget Activity 2040 / 2				**R-1 Program Element (Number/Name)** PE 0602122A / TRACTOR HIP				**Project (Number/Name)** B73 / AB73				
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
B73: *AB73*	-	6.000	-	-	-	-	-	-	-	-	-	-

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)(I)

Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army										**Date:** February 2015	

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

R-1 Program Element (Number/Name)
PE 0602211A *I Aviation Technology*

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
Total Program Element	-	54.667	63.414	56.884	-	56.884	65.914	65.902	68.583	69.932	-	-
47A: *AERON & ACFT Wpns Tech*	-	47.985	55.393	48.377	-	48.377	56.159	55.468	57.886	59.024	-	-
47B: *Veh Prop & Struct Tech*	-	6.682	8.021	8.507	-	8.507	9.755	10.434	10.697	10.908	-	-

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 U.S. Army Aviation and Missile Research, Development, and Engineering Center (AMRDEC), located at Redstone Arsenal, AL; Joint Base Langley Eustis, VA; NASA Ames Research Center, Moffett Field, CA; NASA Langley Research Center, Hampton, VA; and at the U.S. Army Research Laboratory (ARL), located at Adelphi, MD; Aberdeen Proving Ground, MD; Hampton, VA; and Cleveland, OH.

Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army				**Date:** February 2015	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*			**R-1 Program Element (Number/Name)** PE 0602211A *I Aviation Technology*		

B. Program Change Summary ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**
Previous President's Budget	55.586	63.433	57.290	-	57.290
Current President's Budget	54.667	63.414	56.884	-	56.884
Total Adjustments	-0.919	-0.019	-0.406	-	-0.406
• Congressional General Reductions	-	-0.019			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.919	-			
• Adjustments to Budget Years	-	-	-0.406	-	-0.406

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army										Date: February 2015	
Appropriation/Budget Activity 2040 I 2				R-1 Program Element (Number/Name) PE 0602211A I Aviation Technology					Project (Number/Name) 47A I AERON & ACFT Wpns Tech		

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
47A: AERON & ACFT Wpns Tech	-	47.985	55.393	48.377	-	48.377	56.159	55.468	57.886	59.024	-	-

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 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 S&T focus areas and the Army Modernization Strategy.

Work in this project is performed by the Aviation Development Directorate of the U.S. 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 2014	FY 2015	FY 2016
Title: National Rotorcraft Technology Center (NRTC)	3.014	5.055	4.704
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 2014 Accomplishments: Developed modeling tools to determine lubricated/loss-of-lube gear performance; developed measurable criteria for repairable gear tooth damage and standardized repair methods; and executed extensive correlation efforts for time-accurate, analytic coupling methods for model-scale rotors in hover and full scale rotors in forward flight.			
FY 2015 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602211A *I Aviation Technology*	**Project (Number/Name)** 47A *I AERON & ACFT Wpns Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Develop industry accepted criteria and repair methods for lightly damaged gear tooth repair, enhance understanding of surface finish effect on gear noise; improve fatigue life and stress corrosion cracking mitigation for magnesium castings; and explore laser scanning technology to improve the fidelity and speed of housings and dynamic components inspection techniques. *FY 2016 Plans:* Will 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 cost.			
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 2014 Accomplishments:* Conducted test stand preparation for a sub-scale rotor experiment to refine current modeling and simulation tools for rotor structural loads; conducted sub-scale experimental studies in drag reduction using active and passive techniques where combined rotor and fuselage flows are complex; analyzed rotorcraft configurations for improved performance, including both aerodynamics and structural dynamics; developed new software that includes the ability to model high fidelity simulations of helicopter missile launch; conducted analysis and simulation to evaluate autonomous multi-ship teaming (e.g., twin lift); developed and validated flight simulation models of compound high-speed configurations for handling qualities requirements; and initiated development of flight control architectures for advanced configurations with many control surfaces and widely changing dynamic responses over the flight envelope. *FY 2015 Plans:* Conduct 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; improve the accuracy and efficiency of computational software that models full-vehicle rotorcraft aerodynamics on high-performance parallel computers; analyze performance, aerodynamics and structural dynamics for advanced rotorcraft configurations; update Aeronautical Design Standards (ADS-33) to integrate lessons learned from degraded visual environment mitigation and slung load handling qualities measurements into new requirements; develop and simulate methods of controlling dual lift configurations; and analyze and simulate flight control concepts for advanced rotorcraft configurations. *FY 2016 Plans:* Will develop and test high-fidelity computational models of complete rotorcraft for the aerodynamics and dynamics in both straight and level and maneuver flight. Will complete last phase of downwash / outwash flow field beneath a sub-scale rotor in hover	8.704	8.774	9.431

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 I 2	R-1 Program Element (Number/Name) PE 0602211A I Aviation Technology	Project (Number/Name) 47A I AERON & ACFT Wpns Tech

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
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. Will develop innovative diagnostic techniques to measure and improve understanding of interactional aerodynamic phenomena. Will integrate rotors and vehicle management system technologies to reduce rotor loads, reduce hub and airframe drag and improve vehicle performance. Will conduct flight experiments of dual-lift flight control. Will integrate flight control and handling qualities analysis into Army preliminary design tools NASA Design and Analysis of Rotorcraft (NDARC) for advanced rotorcraft configurations. Will initiate piloted handling qualities experiments toward new / revised ADS-33 quantitative and qualitative criteria to address advanced rotorcraft concepts and missions supporting FVL.			
Title: Aircraft and Occupant Survivability Technologies	9.774	9.306	4.494
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 2014 Accomplishments:* Conducted coupon testing of developed electro-optical (EO)/infrared (IR) materials for signature control and environmental durability; began design of advanced systems/subsystems and configurations that provide threat protection against conventional ballistic threats and non-conventional weapons to include directed energy, active crash protection for full spectrum crashworthiness, and crashworthy ballistic tolerant fuel containment systems independent of fuel type. *FY 2015 Plans:* Complete performance and material analyses of lightweight composite transparent armor system and validate analyses through laboratory test; complete chemical analysis of JP-8 and alternative fuel blends; complete fabrication of test specimens for crashworthy ballistic fuel containment systems, and validate analyses through laboratory tests; leverage flight test in part and full mission simulators to validate performance models of active crash protection system algorithms; complete the development of EO/IR materials, and conduct sub-scale testing of developed EO/IR materials for signature control and environmental durability; investigate preliminary near real-time survivability route planning algorithms; investigate Adaptive IR engine suppressor capability designed to optimize IR signature reduction and aircraft lift and range performance. *FY 2016 Plans:* Will develop and evaluate composite armor integrated into primary load bearing structure systems to improve conventional threat protection while reducing overall system weight. Will evaluate passive and active energy attenuating devices integrated into primary structure to improve crashworthiness while reducing overall system weight. Will conduct ballistic and crash experiments on lightweight composite armor components and energy attenuating devices to verify performance. Will begin development of next generation ballistic, crash, and directed energy weapon protection and fuel containment technologies			
Title: Engine and Drives Technologies	4.942	5.083	3.600

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015	
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602211A *I Aviation Technology*	**Project (Number/Name)** 47A *I AERON & ACFT Wpns Tech*	

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
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 2014 Accomplishments:* Completed component testing of advanced combustor designs for reduced size, weight, and cost; initiated fabrication of an advanced power turbine for improved performance and operational capability; investigated clutch and gear systems to permit multi-speed transmissions required for high speed rotor and prop/rotor operation. *FY 2015 Plans:* Complete investigation of advanced variable speed power turbine for improved performance and operational capability; complete alternate engine concepts design and analysis effort; perform conceptual design analysis of advanced integrated engine/flight controls with integrated health management for reduced weight/cost and improved reliability/fault detection; design/fabricate clutchless concepts for multi-speed gearbox component testing; develop integral shaft/bearing races to reduce weight in large gearboxes and investigate new high-strength, corrosion resistant materials for drive system applications. *FY 2016 Plans:* Will 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; initiate design of a smart adaptable efficient filtration system for improved engine performance and durability; and will investigate drive train technologies with multi-speed (ability to vary shaft speed between 50 and 100%) in support of Next Generation Rotorcraft Transmission and Future Vertical Lift 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 2014 Accomplishments:*	5.287	7.493	7.331

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 I 2	R-1 Program Element (Number/Name) PE 0602211A I Aviation Technology	Project (Number/Name) 47A I AERON & ACFT Wpns Tech

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Expanded the vehicle design analysis and modeling environment to improve analytic efficiency, including enhanced component weights methodology, incorporation of vehicle cost methodologies, and linkage of design tools to specialized higher fidelity analytic codes. *FY 2015 Plans:* Continue enhancement and refinement of vehicle costing methodologies and analytical efficiencies and accuracy; apply modeling and simulation tools to design and perform analysis of the Family of Systems (FoS) for Future Vertical Lift (FVL) to support "Zero Maintenance" helicopter concepts; investigate and develop physics of failure modeling to improve reliability of system components, and to enable damage tolerant component design; investigate methods to monitor component loads and integrate with aircraft controls to stay within component failure limits; and investigate modeling and simulation methods to reduce the time required to design and develop new aircraft. *FY 2016 Plans:* Will continue enhancement of the Integrated Design Environment 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. Will apply modeling and simulation tools to support design of FVL/novel concepts and analysis of their operational feasibility. Will enhance probabilistic structural integrity and useful life analytical techniques through improved damage initiation and propagation models; develop and perform building block investigation of high-strain capable, multifunctional structures that offer improvements in structural efficiency and enable ultra-reliable, operationally durable designs.			
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 small UAS performance. When applicable, technologies in this area are leveraged to support mitigation of degraded visual environments. *FY 2014 Accomplishments:* Completed evaluation of brown-out symbology software (BOSS) in actual brown-out conditions at Yuma Proving Ground for approach-to-landing, hover and take-off flight regimes; and evaluated simulation of BOSS symbology for forward tactical flight regimes; evaluated the use of high priority "plays", or pre-defined UAS operational functions, based on pilot feedback from Manned/Unmanned-Teaming (MUM-T) simulation studies. *FY 2015 Plans:* Develop optimal human-machine visual, aural, and tactile interfaces for manned-unmanned teaming that supports efficient mission execution and safe flight operations with high situation awareness for pilots and unmanned aerial system operators. Building 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	5.221	6.489	6.603

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
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 2014	FY 2015	FY 2016
in degraded visual environments; and investigate 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:* Develop, integrate, and test advanced Unmanned Aircraft System (UAS) behaviors and technologies that significantly increase the autonomy, the mission effectiveness, and the ease of use of UAS systems. These advanced behaviors and technologies will be enabling capabilities to support simultaneous control of multiple UASs, advanced Manned Unmanned Teaming operations with smart UASs, and employment of UAS systems under canopy and in dense urban environments. Will 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. Will include close proximity flight in a simulation environment and develop technology for a simulation experiment. Will develop data fusion technologies of both on and off board sensors in a simulation environment.			
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 2014 Accomplishments:* Researched and determined applicability of advanced sensor technologies for improved situational awareness; researched lightweight remote control weapons turrets to eliminate the need for dual door gunners, and advanced weapons system management algorithms for reconnaissance, attack, and utility aircraft. *FY 2015 Plans:* Investigate integrated targeting/intelligence, surveillance, and reconnaissance (ISR) sensors and alternative targeting sensors; assess emerging lethal and non-lethal deterrent weapons capabilities for development and aircraft integration; and prepare the lightweight remote control system for follow on testing. *FY 2016 Plans:* Will develop sensor integration architecture and networking standards to enable the capability to quickly and easily integrate sensor systems onto Army aircraft, and to enable more seamless sensor and imaging data fusion. Will conduct lab based sensor networking and experimentation to verify the enhanced sensor integration and fusion capabilities. Will 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. Will continue to support AMRDEC Missile PE 0603313A, and CERDEC NVESD, 0603710	1.596	1.613	1.604

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
Appropriation/Budget Activity 2040 I 2	R-1 Program Element (Number/Name) PE 0602211A I Aviation Technology	Project (Number/Name) 47A I AERON & ACFT Wpns Tech	

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
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.			
Title: Maintainability & Sustainability Technologies	3.548	3.580	2.104
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 2014 Accomplishments:** Developed technologies to enable lighter weight designs through loads monitoring of critical components; developed multi-use sensors to monitor cracking and delamination in composites as well as crack growth algorithms; developed wireless sensors for on-component processing of part health and usage history; investigated probabilistic failure initiation and progression analysis methods to estimate remaining component life, including improved analysis techniques for metallic and composite rotating and non-rotating structures; investigated methodologies to allow for probability of failure predictions based on vehicle current state and anticipated mission, and developed improved load and usage spectrum characterization techniques; and investigated durable structural concepts including application of high-strain capability designs through advanced design, analysis and/or material solutions, while also considering repairability. **FY 2015 Plans:** Develop embedded multifunctional sensors with built-in processing and communications; develop health assessment systems to support adaptive controls; develop technologies for component self assessment, usage tracking and embedded history; and investigate technologies to provide health monitoring to support and optimize design efficiencies. **FY 2016 Plans:** Will investigate use of wireless communication technologies to reduce wiring weight associated with prognostics and diagnostics; will integrate health assessment technologies into Joint Common Architecture (JCA)/avionics/cockpit; will develop fly-by-wire (FBW) with CBM monitoring capability; will develop miniaturized wireless sensors with on-component processing, history and parts tracking; will develop improved fleet management capability with autonomous logistics for parts/production control; will investigate technologies for in-flight data transmission to ground.			
Title: Survivability For Degraded Visual Environment Operations	5.899	8.000	8.506
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.) degraded visual environment. Work in this area is being done in coordination with efforts at U.S. Army Communications-Electronics Research, Development, and Engineering Center (CERDEC), PE 603710A, Night Vision Advanced Technology.			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
Appropriation/Budget Activity 2040 I 2	**R-1 Program Element (Number/Name)** PE 0602211A I *Aviation Technology*	**Project (Number/Name)** 47A I *AERON & ACFT Wpns Tech*	

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
FY 2014 Accomplishments: Executed studies that include simulation, laboratory, ground test, and flight test to determine the parametric relationship between aircraft handling qualities, sensors and cueing to allow safe flight operations in degraded visual environments; defined and began implementation of improved flight controls, multi-modality sensor fusion and advanced cueing (symbology, tactile, and aural). Began execution of the first cueing experiment at USAARL that is investigating symbology, aural and tactile cueing trade-offs. *FY 2015 Plans:* Investigate multi-resolution fusion sensor package comprised of a 94 GHz millimeter wave radar, a laser radar (LADAR) and an infrared (IR) camera; investigate alternative fusion techniques with a different form of LADAR and an IR camera; conduct experiments focused on optimizing the forward flight modernized control laws (MCLAWS) of the UH-60 aircraft in preparation for a planned FY16 NATO capstone flight test; and explore the value of additional cueing techniques such as tactile and aural technologies in the AMRDEC simulation facility at Redstone Arsenal, Alabama. This work feeds a 6.3 Degraded Visual Environment mitigation tech demo effort beginning in FY16. *FY 2016 Plans:* Execute a second iteration of experimentation at US Army Aeromedical Research Laboratory (USAARL) simulation facility (Fort Rucker, AL) focusing on symbology, tactile and aural technologies trades and optimization. Continue software algorithm and material 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.			
Accomplishments/Planned Programs Subtotals	47.985	55.393	48.377

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 2016 Army											Date: February 2015	
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602211A *I Aviation Technology*					**Project (Number/Name)** 47B *I Veh Prop & Struct Tech*			
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
47B: *Veh Prop & Struct Tech*	-	6.682	8.021	8.507	-	8.507	9.755	10.434	10.697	10.908	-	-

Note
Not applicable for this item.

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 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 S&T focus areas and the Army Modernization Strategy.

Work in this project is performed by the U.S. Army Research Laboratory (ARL) at the 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 2014**	**FY 2015**	**FY 2016**
Title: Rotor and Structure Technology	2.229	2.398	2.547
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 rotor and structure to significantly improve rotorcraft range and speed. *FY 2014 Accomplishments:* Developed and demonstrated seat damper technology using "smart magnetic material" that will enhance the crash-worthiness of rotorcraft; evaluated the performance of an advanced, structurally-integrated, trailing edge rotor flap for its simplicity of operation and aerodynamic control authority; performed prognostic and diagnostic (P&D) inspection experiments aimed at improving structural risk assessment; developed self sensing strategies to monitor damage precursors; incorporated optimized sensing strategies into P&D systems; commissioned operation of, and began data collection on the full scale helicopter landing gear test stand facility; utilized multi-functional structural materials to augment sensing, power and energy storage, or actuation in micro air and ground vehicles; developed coupled plasma/fluid models and utilized computational models to quantitatively assess potential impacts of plasma on rotor aerodynamic performance; began experimental studies to determine the potential of nanosecond			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
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 2014	FY 2015	FY 2016
pulsed plasma discharges for enhancing current and next-gen rotorcraft speed, range, and payload; developed quantitative technology payoff assessment and analysis models; and expanded models from first-order relationships to comprehensive codes to allow researchers to understand which technologies are the most critical to achieving future aviation capabilities. *FY 2015 Plans:* Investigate novel approaches to improve rotorcraft vehicle maintainability; investigate the feasibility of aeroelastic/aeromechanical stability enhancement of composite rotor blades through novel material concepts; develop wind-tunnel models to study advanced active-control helicopter rotor systems; develop advanced structural dynamics models of rotorcraft fuselage structures; and explore and evaluate plasma discharge based active flow control techniques for rotor dynamic stall alleviation and diffuser augmented rotor systems. *FY 2016 Plans:* Will 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.			
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 2014 Accomplishments:* Completed evaluation of the potential for variable speed power turbines to enable efficient operation of gas turbine engines at reduced power operating conditions to enable faster rotorcraft vehicles; and completed dynamic characterization of a Pericyclic Variable Transmission (PVT). *FY 2015 Plans:* Evaluate 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 demonstrate drive train technologies with 50% increase in time-to-scuffing-failure after lubricant supply is terminated in a simulated gear environment and identify promising technologies to achieve +50% oil-out time in support of Next Generation Rotorcraft Transmission objectives. *FY 2016 Plans:* Will 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 Unmanned Aerial System (UAS) engines using both experimentation and modeling to mature optimization tools for efficient fuel combustion to increase UAS mission capabilities.	3.863	3.113	3.198
Title: Micro/Small Scale Unmanned Aerial Systems	0.590	1.510	1.762

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602211A *I Aviation Technology*	**Project (Number/Name)** 47B *I Veh Prop & Struct Tech*	

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Description: Investigated platform, aerodynamic, actuation, transmission, and control technologies for handheld autonomous Unmanned Aerial Systems (UAS); provided small units with significantly increased tactical mobility and deployability by extending soldier perception to real-time local Intelligence, Surveillance, and Reconnaissance (ISR) with handheld organic assets, and by minimizing the supporting infrastructure needed for deployment. *FY 2014 Accomplishments:* Developed and used various levels of model fidelity, including High-Performance Computing (HPC) modeling and simulation, experimentation, and evaluation, to advance and improve the coupled wing-actuator-control system and its components, where component-level investigation includes, but is not limited to, aspects of low speed airfoil design, airfoil turbulence sensitivity analysis, implementation-plausible (at the handheld-scale) flow control, and membrane and tendon-like actuation. *FY 2015 Plans:* Transition open loop control strategies employing active aerodynamic or elastic actuation to aircraft form factors for achieving gust and other disturbance rejection capability; incorporate bio-inspired sensors for enhanced state and disturbance awareness; evaluate technologies addressing the communication and processing needs of size, weight, and power constrained platforms; develop an aeromechanics analysis tool integrating fluid dynamics and structural dynamics solvers; investigate wing flexibility/morphing for performance enhancements; and perform 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:* Will demonstrate a span-adaptive wing which yields relatively consistent performance across its span range while responding to slowly varying conditions in a wind tunnel; and demonstrate with low degree-of-freedom surrogates, energy conservative behaviors inspired from biology.			
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 Plans:* Develop and improve failure models to characterize and categorize specific material damage precursors relevant to aviation components; develop a probabilistic framework for predicting remaining useful life of vehicle platforms; investigate the integration	-	1.000	1.000

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602211A *I Aviation Technology*	**Project (Number/Name)** 47B *I Veh Prop & Struct Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
of advanced aviation component health monitoring techniques into health-usage monitoring systems (HUMS); and develop self-sensing structural material technologies that incorporate damage precursor detection philosophy. *FY 2016 Plans:* Will develop the Virtual Risk-informed Agile Maneuver Sustainment (VRAMS) concept, which will evaluate 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 enable fatigue-free and zero-maintenance aircraft components.			
Accomplishments/Planned Programs Subtotals	6.682	8.021	8.507

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 2016 Army										**Date:** February 2015	

Appropriation/Budget Activity	**R-1 Program Element (Number/Name)**
2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	PE 0602270A *I Electronic Warfare Technology*

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
Total Program Element	-	17.464	18.500	19.243	-	19.243	20.466	21.041	21.322	21.737	-	-
906: *Tactical Electronic Warfare Applied Research*	-	17.464	18.500	19.243	-	19.243	20.466	21.041	21.322	21.737	-	-

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 complimentary 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 2016 Army				**Date:** February 2015	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*			**R-1 Program Element (Number/Name)** PE 0602270A *I Electronic Warfare Technology*		

B. Program Change Summary ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**
Previous President's Budget	17.575	18.502	19.383	-	19.383
Current President's Budget	17.464	18.500	19.243	-	19.243
Total Adjustments	-0.111	-0.002	-0.140	-	-0.140
• Congressional General Reductions	-	-0.002			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.111	-			
• Adjustments to Budget Years	-	-	-0.140	-	-0.140

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army											Date: February 2015	
Appropriation/Budget Activity 2040 I 2				**R-1 Program Element (Number/Name)** PE 0602270A I *Electronic Warfare Technology*					**Project (Number/Name)** 906 I *Tactical Electronic Warfare Applied Research*			
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
906: *Tactical Electronic Warfare Applied Research*	-	17.464	18.500	19.243	-	19.243	20.466	21.041	21.322	21.737	-	-

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 2014**	**FY 2015**	**FY 2016**
Title: Multi-Intelligence Data Fusion and Targeting	2.767	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 PE 0603772A/project 243 compliments this effort. *FY 2014 Accomplishments:*			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
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 2014	FY 2015	FY 2016
Investigated cultural, psychological, social and physical environment and time variables for improving automated reasoning and analysis software ability to track and make associations between persons, places and events of interest; researched political, military, economic, social, infrastructure and information (PMESII) data standards and developed models to assess how cultural and PMESII factors can influence support or alter decisions during military planning and execution. *FY 2015 Plans:* Investigate methods to fuse biometric enabled intelligence analysis results with other forms of intelligence data to improve the overall quality of data products; design methods and analysis software tools and algorithms to extract biometric and contextual data from streaming video sources; begin design and coding of software tools to assign quality scores to data gathered from non-dedicated biometric sources. *FY 2016 Plans:* Will 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.			
Title: Offensive Information Operations Technologies *Description:* This effort designs, codes and evaluates cyber 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 compliments this effort. *FY 2014 Accomplishments:* Refined cyber effects and situational awareness techniques for various protocols and signals-of-interest (SOIs); enhanced current electronic warfare networking protocol extensions as applicable to enable tactical cyber capabilities; developed advanced cyber techniques. *FY 2015 Plans:* Investigate the impacts on cyber/EW techniques of converging disparate RF devices into a common hardware and software platform; develop coordinated cyber/EW techniques to exploit tactically relevant targets; analyze and develop performance predictions for various techniques being employed on different cyber and EW platforms. *FY 2016 Plans:*	5.028	5.899	5.843

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602270A *I Electronic Warfare Technology*	**Project (Number/Name)** 906 *I Tactical Electronic Warfare Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Will investigate advanced techniques against next-generation SOIs; research an architecture for resilient operations across cyber, EW and signal intelligence assets; investigate extending cyber enabled operations to software defined radio platforms such as dismounted/mounted radio and/or next generation radar systems.			
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 2014 Accomplishments:*** Validated M&S environment and new countermeasure techniques; validated digital seeker hardware surrogate performance in the modeling environment and HIL simulations; evaluated known countermeasures in the M&S environment to assess effectiveness; investigated new countermeasure techniques to use against advanced threats. ***FY 2015 Plans:*** Evaluate effectiveness of current countermeasures techniques against additional classes of emerging multi-spectral threats required by Common IR Countermeasures program of record; expand laboratory and M&S environment to accommodate assessment of advanced threat countermeasures; initiate design, fabrication and encoding of techniques and technologies that provide countermeasures against multi-spectral IR and RF threats; investigate multi-band signature management exploitation and design correlation techniques for improved threat detection, identification and countermeasures. ***FY 2016 Plans:*** Will 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.	3.678	5.332	5.309
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 operations. Efforts focus on networking of sensors and open, scalable common RF architectures for terrestrial and aerial sensors. Work being accomplished under PE 63772/243 complements this effort. ***FY 2014 Accomplishments:***	3.733	3.349	4.171

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602270A *I Electronic Warfare Technology*	**Project (Number/Name)** 906 *I Tactical Electronic Warfare Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Assessed radar waveforms designed to coordinate radar sensors without the need for a central interface node, facilitating radar data sharing and cross cueing; investigated and analyzed the performance of noise correlation radar algorithms in operationally relevant hardware platforms to assess their ability to mitigate signal interception and compromise, reducing co-site interference and preserving high resolution target detection capability. *FY 2015 Plans:* Study 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; establish metrics for measuring and judging the quality of SAR motion video products; investigate techniques to identify and mitigate the impact of intentional red force interference sources on friendly ISR assets. *FY 2016 Plans:* Will 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.			
Title: Electronic Warfare Architectures and Countermeasures *Description:* This effort investigates and evaluates the technical specifications of a family of threats to develop nonkinetic countermeasures. Work being accomplished under PE 0603270A/project K16 compliments this effort. *FY 2014 Accomplishments:* Analyzed existing EW system components to determine if they may be dual use to address multiple threats or types of threats; developed extensions to traditional EW system architecture to enable a new EW architecture comprised of distributed peripheral components that can be centrally controlled and managed; identified and assessed critical components associated with known and emerging threat devices to support laboratory assessments through component and/or surrogate experiments; designed and coded modeling and simulation resources to enable live, virtual and constructive electronic warfare laboratory assessments. *FY 2015 Plans:* Analyze 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; investigate 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:* Will 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	2.258	1.200	1.200

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602270A *I Electronic Warfare Technology*	**Project (Number/Name)** 906 *I Tactical Electronic Warfare Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
mission functions (Signals Inteligence, EW, Comms); design software for automated classification, detection, identification and correlation algorithm to coordinate EW/SIGINT/Comms transmissions for real time communications across those mission functions.			
Accomplishments/Planned Programs Subtotals	17.464	18.500	19.243

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 2016 Army											Date: February 2015	

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

R-1 Program Element (Number/Name)
PE 0602303A I *Missile Technology*

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
Total Program Element	-	58.426	62.180	45.053	-	45.053	44.313	45.326	46.744	47.543	-	-
214: *Missile Technology*	-	50.426	46.180	45.053	-	45.053	44.313	45.326	46.744	47.543	-	-
G05: *MISSILE TECHNOLOGY INITIATIVES (CA)*	-	8.000	16.000	-	-	-	-	-	-	-	-	-

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), 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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Previous President's Budget	59.500	46.194	45.382	-	45.382
Current President's Budget	58.426	62.180	45.053	-	45.053
Total Adjustments	-1.074	15.986	-0.329	-	-0.329
• Congressional General Reductions	-	-0.014			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	16.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.074	-			
• Adjustments to Budget Years	-	-	-0.329	-	-0.329

Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army	Date: February 2015
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602303A *I Missile Technology*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2014	FY 2015
Project: G05: *MISSILE TECHNOLOGY INITIATIVES (CA)*		
Congressional Add: *Program Increase*	8.000	16.000
Congressional Add Subtotals for Project: G05	8.000	16.000
Congressional Add Totals for all Projects	8.000	16.000

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army											Date: February 2015	
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 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
214: *Missile Technology*	-	50.426	46.180	45.053	-	45.053	44.313	45.326	46.744	47.543	-	-

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 logistics burden of precision munitions.

This project supports the Lethality and C3I portfolios.

Major products of this 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 2014**	**FY 2015**	**FY 2016**
Title: Smaller, Lighter, Cheaper Tactical Missile Technologies	6.294	8.809	-
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 2014 Accomplishments:* Finalized design of a small, light weight, low power, robust navigation sensors developed for on-the-move targeting; completed integration and test of a lightweight composite housing for far target location systems; completed initial design of extended-range, reduced time-of-flight, smaller form-factor insensitive propulsion technology for multiple-mission applications; continued trade studies of the next-generation close-combat, precision weapon systems for performance against increased target sets (e. g., lethality, guidance); developed advanced sensor and tracking technologies for improved target acquisition. *FY 2015 Plans:* Complete design, fabricate, and test advanced composite housing for Javelin Light Weight Command Launch Unit (LW CLU); fabricate and test a small, light weight, low power inertial navigation sensor developed for robust man-portable close-combat targeting performance, and complete design of an increased accuracy modular inertial navigation sensor with reduced size,			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
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 2014	FY 2015	FY 2016
weight, and power (SWaP) and on-the-move capabilities (both targeting and navigation); fabricate and test reduced SWaP, increased range acquisition sensor for Javelin LW CLU; integrate components into CLU housing and evaluate; continue trade studies of the next-generation close combat, precision weapon systems for performance against increased target sets; develop and test advanced guidance and tracking technologies for improved target acquisition at increased range; investigate, develop and evaluate 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 2014 Accomplishments:* Integrated and demonstrated sub-components for beam steering, power generation, and thermal management of phased array seeker designs; developed, integrated, and evaluated affordable phased array seeker solutions that enable all-weather operation; completed fabrication and integration of seeker components for very small interceptors to counter unmanned aviation systems (UAS) and integrated into reduced-weight weapons to arm small U.S. UAS designs; characterized and field-tested novel infra-red camera microcooler technology with performance comparable to current uncooled seekers. *FY 2015 Plans:* Continue technology maturation of novel micro-cooler technologies for advanced infrared tactical seekers to increase range performance and improve size, weight, and power; test 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; integrate programmable laser proximity sensor components and filter algorithms that will maintain operation in the presence of obscurants; complete the development of advanced technologies for affordable phased array sensors that enable all-weather operation of missile seekers and fire control. *FY 2016 Plans:* Will fabricate, integrate, and begin testing of 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.	8.744	7.631	3.757
Title: Missile Guidance, Navigation and Controls Technologies *Description:* This effort designs, fabricates and evaluates guidance, navigation, and control systems and software, as well as information and signal processing systems for rocket and missile applications. Goals of this effort include more affordable missile guidance; miniaturization of guidance electronics; maintaining performance in global positioning system (GPS) denied	6.874	6.809	6.437

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
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 2014	FY 2015	FY 2016
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 2014 Accomplishments:* Continued the design, development, integration and evaluation of high-precision inertial components and systems that allow faster/higher-accuracy positional alignment of far target location systems, and missile navigation in environments of high dynamic-maneuvers as well as environments where reliance on the Global Positioning System (GPS) cannot be assured; developed and evaluated emerging low-cost terrain/stellar (celestial) navigation technologies (including algorithms) for application to precision long-range stand-off fires that have the capability to operate in an environment where reliance on the GPS is not assured; designed, and evaluated second-iteration embedded structural electronics that enable smaller, lower-cost airframe designs. *FY 2015 Plans:* Develop, integrate and evaluate 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, unique inertial systems and GPS Anti-Jam /Anti-Spoofing systems; continue to develop, integrate and demonstrate state-of-the-art integration techniques for COTS inertial sensors representing low cost, high accuracy navigation systems for extremely dynamic missile environments; develop, integrate, and demonstrate inertial technologies aimed at reducing size, weight, power and cost, while increasing accuracy. *FY 2016 Plans:* Will 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.			
Title: Missile Fire Control Systems, Sustainment, Simulations, and Launchers *Description:* This effort designs and evaluates fire control and tracking sensor technologies for area protection and air defense, technologies to increase missile useful life and reliability, advanced simulations to increase performance and reduce size, weight, and cost of missile systems, and launcher technology to deliver effects from air and ground platforms. Fire control radar effort is in coordination with PE 0602270A, Project 906 and PE 0603772A, Project 243. *FY 2014 Accomplishments:* Developed application-ready missile health monitoring technologies for shelf-life sensing of high-payoff components that improves the quality and quantity of missile health source data, reduces missile sustainment costs, and increases readiness; further	3.316	2.888	5.473

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
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 2014	FY 2015	FY 2016
developed the Non Cooperative Target combat identification algorithms and integrate into air defense radars; evaluated and quantified performance of Electronic Steered Arrays for air defense radars. *FY 2015 Plans:* Develop 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 develop target identification algorithms for integration with radar systems to increase targeting fidelity. Continue development of missile health monitoring unit to improve user interface to reduce sustainment costs and increases readiness; optimize health monitoring units for reduced cost, power, and volume and operation in dynamic vibration environments using micro-electromechanical systems (MEMS). *FY 2016 Plans:* Will 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 develop 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.			
Title: Missile Propulsion, Structures, Lethality, and Aerodynamic Technology *Description:* This effort designs, fabricates, evaluates and tests missile enabling technologies including: advanced missile propulsion with reduced launch signatures; increased lethality and range of lethality effects; improved structural integrity of light weight missile cases; and increased understanding of missile aerodynamics for improved performance. *FY 2014 Accomplishments:* Fully characterized the most promising minimum-signature propellants with enhanced cold temperature strain capability that can be used in operational-environment temperature extremes encountered by unmanned aviation systems; conducted static tests of advanced thermal barriers for pulsed-motors; designed novel ignition systems that reduce propulsion system ignition delay and increase the energy release efficiency; continued rocket motor survivability/reliability assessments and prediction modeling; evaluated high performance compact warhead designs in collaboration with the Armaments Research, Development, and Engineering Center. *FY 2015 Plans:* Test novel propulsion structures to increase missile range and decrease time of flight of minimum signature propulsion systems; develop vibration-induced material degradation models of propulsion systems for stockpile reliability models to extend missile life; develop new methodologies that accurately characterize base flow predictions for complex aft bodies to improve aerodynamic	5.032	5.951	6.069

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 2014	FY 2015	FY 2016

predictability; continue modeling and analysis to determine the vulnerability of UASs to fragment impact and blast effects to enable the design of counter UAS missiles; continue to evaluate high performance compact warhead designs in collaboration with the Armaments Research, Development, and Engineering Center.

FY 2016 Plans:
Will 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 begin system integration tests of lightweight warhead case technologies to provide reinforced structure defeat capability; investigate, scale up and test emerging disruptive energetic material from U.S. 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.

	10.437	8.106	8.543

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.

FY 2014 Accomplishments:
Continued identification of critical component technology for next-generation air defense and long-range fires systems, conducted component performance trade studies and began the component designs, conducted initial laboratory evaluations of the component technologies, and finalized an integrated system architecture; updated the all-digital simulation to reflect new navigation component technology designs and propulsion energy management technologies for long-range stand-off missiles; completed evaluation of component designs for lightweight multi-role (air-to-ground/air-to-air) missiles that can be integrated onto all sizes of unmanned aviation systems as well as manned rotary wing platforms; performed laboratory testing to determine feasibility to support attack of a larger target set.

FY 2015 Plans:
Utilize data fusion to incorporate new navigation technologies into missile navigation algorithms aiding GPS and inertial navigation for operation in GPS-denied environments, evaluate propulsion energy management technologies, and perform trade studies of new payload technologies for long-range missiles; conduct component performance trade studies; continue 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; investigate alternate component technologies for seeker and guidance

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
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 2014	FY 2015	FY 2016
electronic unit design cost reduction and with no performance degradation; evaluate and assess new alternate lightweight/high strength materials to increase weapon survivability and reduce soldier weight burden. *FY 2016 Plans:* Will 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.			
Title: Large Long Range Future Fires *Description:* This effort evaluates and develops 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 2014 Accomplishments:* Developed a simulation and conduct analyses of large long-range fires propulsion system requirements; developed candidate propulsion system designs and performed trade studies to distinguish the most promising technologies; and developed detailed propulsion system design(s) of the most promising technology. *FY 2015 Plans:* Continue to update propulsion models and conduct analyses of large long-range fires propulsion system requirements; design, fabricate, and perform initial testing of propulsion sub-systems that will enable Large Long Range Future Fires capability.	4.879	2.994	-
Title: Micro Inertial Navigation Sensor for Networked Javelin Command Launch Unit (CLU) with External Far Target Locator (FTL) *Description:* This effort focuses on the design, fabrication, and evaluation of reduced size, weight, and power advanced inertial sensor technology for use in highly-accurate robust targeting by a man-portable system. *FY 2014 Accomplishments:* Finalized initial design of a small, light weight, low power navigation sensor developed for robust man-portable close-combat targeting performance with on-the-move capabilities (both targeting and navigation) to include operation in environments where reliance on the Global Positioning System cannot be assured.	2.000	-	-
Title: Air Defense Missile Technologies (formerly Counter Unmanned Aerial Systems and Counter Cruise Missile)	2.850	2.992	6.188

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602303A *I Missile Technology*	**Project (Number/Name)** 214 *I Missile Technology*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Description: This effort evaluates and develops 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 2014 Accomplishments:* Identified, characterized, and tested effects of lethality mechanisms against potential UAS threats. Developed models based on results to predict effectiveness of lethal mechanisms against UAS. Evaluated other components, such as power sources, tracker algorithms, and fire control for counter UAS mission. *FY 2015 Plans:* Evaluate and analyze component technologies to support the counter UAS mission and expand efforts to include tactical level air threats with 360 degree coverage. Begin component level modeling and simulation and evaluate system architecture concepts. *FY 2016 Plans:* Will 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.			
Title: Affordable Precision Missile Enabling Technology *Description:* This effort focuses on the studies, design, development, 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:* Will 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.	-	-	2.000
Title: Long Range Fires Enabling Technology *Description:* This effort focuses on performing the necessary trade studies, and designing, developing, 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:*	-	-	6.586

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
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 2014**	**FY 2015**	**FY 2016**
Will 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 Global Position System (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.			
Accomplishments/Planned Programs Subtotals	50.426	46.180	45.053

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 2016 Army											Date: February 2015	
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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
G05: *MISSILE TECHNOLOGY INITIATIVES (CA)*	-	8.000	16.000	-	-	-	-	-	-	-	-	-

A. Mission Description and Budget Item Justification
 This is a Congressional Interest Item.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015
Congressional Add: Program Increase	8.000	16.000
FY 2014 Accomplishments: Supported efforts in Long Range Fires Enabling Technologies;: Counter-Unmanned Aerial Systems (C-UAS) Enabling Technologies; Modular Missile Technologies; and Energetic Materials for Propulsion.		
FY 2015 Plans: Program increase for missile technology research		
Congressional Adds Subtotals	8.000	16.000

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 2016 Army											Date: February 2015	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					**R-1 Program Element (Number/Name)** PE 0602307A *I Advanced Weapons Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
Total Program Element	-	25.310	38.513	29.428	-	29.428	28.803	22.774	21.346	30.378	-	-
042: *High Energy Laser Technology*	-	25.310	28.513	29.428	-	29.428	28.803	22.774	21.346	30.378	-	-
NA5: *Advanced Weapons Components (CA)*	-	-	10.000	-	-	-	-	-	-	-	-	-

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 U.S. 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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Previous President's Budget	26.148	28.528	29.641	-	29.641
Current President's Budget	25.310	38.513	29.428	-	29.428
Total Adjustments	-0.838	9.985	-0.213	-	-0.213
• Congressional General Reductions	-	-0.015			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	10.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.838	-			
• Adjustments to Budget Years	-	-	-0.213	-	-0.213

Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602307A *I Advanced Weapons Technology*	

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2014	FY 2015
Project: NA5: *Advanced Weapons Components (CA)*		
Congressional Add: *Directed energy/thermal management program increase*	-	10.000
Congressional Add Subtotals for Project: NA5	-	10.000
Congressional Add Totals for all Projects	-	10.000

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army										Date: February 2015	
Appropriation/Budget Activity 2040 I 2				**R-1 Program Element (Number/Name)** PE 0602307A I *Advanced Weapons Technology*						**Project (Number/Name)** 042 I *High Energy Laser Technology*	
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
042: *High Energy Laser Technology*	-	25.310	28.513	29.428	-	29.428	28.803	22.774	21.346	30.378	-	-

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 lasers 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 analysis 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 U.S. 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 2014	FY 2015	FY 2016
Title: Solid State Laser (SSL) Effects	7.719	5.792	5.426
Description: This effort provides the underlying data required to support system engineering designs, lethality analysis, and modeling and simulation (M&S) tools for laser weapon systems. This effort includes the operation of the Solid State Laser Testbed (SSLT), a 100kW class laser testbed located at the HELSTF for conducting SSL effects experiments in an open air environment. *FY 2014 Accomplishments:* Returned SSLT laser and clean room to fully operational standards to complete transfer of SSLT operations and maintenance responsibility to White Sands Missile Range (WSMR) HELSTF; continued static and dynamic experiments to investigate performance of the SSLT against mortars and unmanned aerial platforms and used data collected to refine and validate M&S codes. *FY 2015 Plans:* Upgrade SSLT lethality data collection capability to collect better represented lethality data to improve lethality models and better predict integrated high energy laser demonstration performance; use lethality data to improve laser weapon system			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602307A *I Advanced Weapons Technology*	**Project (Number/Name)** 042 *I High Energy Laser Technology*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
battle management capability against Rockets, Artillery, and Mortar (RAM) and Unmanned Aerial System (UAS) targets; begin 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; continue validation and analysis of atmospheric effects on the propagation of a 1.06 micron SSL. *FY 2016 Plans:* Will conclude SSLT lethality data collection effort on representative RAM and basic UAS targets; conduct field performance validation, analyze data, and provide lethality data for the HEL MD 50kW class demonstration; 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.			
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 ground platforms. This work is done in collaboration with the HEL JTO and other Services. *FY 2014 Accomplishments:* Demonstrated performance of refractive, light weight beam director and used data to update and validate models for component maturity; completed development of the aperture sharing element of the light weight beam director and demonstrated the jitter performance and track stability required for a mobile HEL weapon system; began the integration of an Adaptive Optics (AO) system that will allow for improved beam propagation. *FY 2015 Plans:* Begin 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; continue 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; complete analysis and subscale experiments using segmented mirrors to demonstrate improved ability to correct wavefront errors in a high energy laser. *FY 2016 Plans:* Will 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; begin development of a breadboard All-Weather Tracker that integrates algorithms and the sensor sub-system that will be	1.225	4.066	3.283

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015
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 2014	FY 2015	FY 2016
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.			
Title: High Efficiency Laser Development	15.157	16.965	19.102

Description: This effort develops component technologies that increase SSL wall-plug efficiencies, which will lead to reductions in size and weight for multiple subsystems that greatly improve the ability to integrate SSL systems into mobile Army weapon platforms. This work is done in collaboration with the HEL JTO and other Services. Selected laser design will be fabricated and integrated with the High Energy Laser Mobile Demonstrator (HEL MD) developed in 0603004A, Project L96.

FY 2014 Accomplishments:
Completed environmental testing on fiber laser subcomponents to support the rugged 50kW efficient laser critical design and conducted subscale experiments and analysis to ensure it will be compatible with the HEL MD ruggedness, reliability, and affordability factors; completed high efficient laser component design requirements and risk reduction testing of the rugged fiber laser amplifier, fiber array holder, and the Multi-Layer Dielectric (MLD) grating and holder; completed the rugged fiber laser component development and began the purchase of long lead items for laser fabrication, such as high efficient laser diode pumps, efficient high power ytterbium doped fibers, and laser control electronics; and completed the design and fabrication of the rugged, high power beam combination optical element.

FY 2015 Plans:
Complete critical design review on efficient high power rugged laser for future integration into HEL MD; purchase 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; complete design and spectral beam combiner component risk reduction experiments to support scaling up to 100kW; begin initial subcomponent integration; conduct improved laser thermal management risk reduction experiments and verify performance of two-phase cooling approach to improve magazine depth; complete fabrication of one double-density Fiber Laser Module (FLM) and two additional fiber laser modules to support the manufacture readiness review; complete maintenance concept plan for the high power rugged laser line replaceable units.

FY 2016 Plans:
Will 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 the HEL MD and complete all the interface

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015
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 2014	FY 2015	FY 2016
specifications; validate performance of a laser system integrated refrigerant cooling subsystem meeting runtime and duty cycle performance requirements; and complete assessment of efficient laser power scaling to >100kW.			
Title: HEL Research and Development and Concepts Analysis Laboratories *Description:* This effort focuses on developing in-house expertise through SSL assessments and starting in FY15, other SMDC/ARSTRAT technical core competencies, including air and missile defense, responsive space, and small satellites. *FY 2014 Accomplishments:* Completed the analysis of an Adaptive Optics (AO) system and transitioned the hardware and algorithms to the light weight beam director effort for integrated tactical performance assessments; began performance demonstrations using hardware and algorithms for correcting laser propagation in deep turbulence; began development of an all weather tracker that is compatible with a laser weapon system. *FY 2015 Plans:* Complete Adaptive Optics (AO) performance demonstrations of advanced AO algorithms for transition to the HEL MD AO system; purchase pump diodes and scaled electric/Radio Frequency discharge sources and begin diode pump gas laser scaling experiments; develop models of space environment effects on small spacecraft; perform orbital assessments of nanosatellite spacecraft and constellation concepts; and investigate concepts in support of space, missile, rocket, and mortar defense. *FY 2016 Plans:* Will 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.	1.209	1.690	1.617
Accomplishments/Planned Programs Subtotals	25.310	28.513	29.428

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

D. Acquisition Strategy
 N/A

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602307A *I Advanced Weapons Technology*	**Project (Number/Name)** 042 *I High Energy Laser Technology*

E. Performance Metrics

 N/A

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army											**Date:** February 2015	
Appropriation/Budget Activity 2040 *I* 2					**R-1 Program Element (Number/Name)** PE 0602307A *I Advanced Weapons Technology*					**Project (Number/Name)** NA5 *I Advanced Weapons Components (CA)*		
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
NA5: *Advanced Weapons Components (CA)*	-	-	10.000	-	-	-	-	-	-	-	-	-

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 2014**	**FY 2015**
Congressional Add: Directed energy/thermal management program increase	-	10.000
FY 2015 Plans: Directed energy/thermal management program increase		
Congressional Adds Subtotals	-	10.000

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 2016 Army											**Date:** February 2015	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					**R-1 Program Element (Number/Name)** PE 0602308A *I Advanced Concepts and Simulation*							
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
Total Program Element	-	23.364	27.423	27.862	-	27.862	28.288	29.931	31.345	31.970	-	-
C90: *Advanced Distributed Simulation*	-	17.086	20.933	21.041	-	21.041	21.189	24.503	24.820	25.315	-	-
D02: *Modeling & Simulation For Training And Design*	-	6.278	6.490	6.821	-	6.821	7.099	5.428	6.525	6.655	-	-

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 U.S. 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 2016 Army			**Date:** February 2015	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*		**R-1 Program Element (Number/Name)** PE 0602308A *I Advanced Concepts and Simulation*		
B. Program Change Summary ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**
Previous President's Budget	24.051	27.435	28.059	-	28.059
Current President's Budget	23.364	27.423	27.862	-	27.862
Total Adjustments	-0.687	-0.012	-0.197	-	-0.197
• Congressional General Reductions	-	-0.012			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.687	-			
• Adjustments to Budget Years	-	-	-0.197	-	-0.197

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army										Date: February 2015	
Appropriation/Budget Activity 2040 I 2				R-1 Program Element (Number/Name) PE 0602308A I Advanced Concepts and Simulation						Project (Number/Name) C90 I Advanced Distributed Simulation	

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
C90: Advanced Distributed Simulation	-	17.086	20.933	21.041	-	21.041	21.189	24.503	24.820	25.315	-	-

Note
Not applicable for this item.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Live, Virtual, Constructive (LVC) Simulations	6.524	8.201	8.124
Description: This effort develops and investigates Live, Virtual and Constructive (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. Developed methods and technologies are transitioned to PE 0603015A/Project S29. **FY 2014 Accomplishments:** Explored technologies and methods to provide Soldiers with an adaptive learning environment, tailored to the individual Soldier; conducted assessments of a prototype training development environment that delivered training content to various software environments on different hardware platforms, including mobile devices; conducted assessments on common processes and technologies for LVC to ease the difficulty and expense of using LVC distributed simulation for Joint and Coalition Warfare			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602308A *I Advanced Concepts and Simulation*	**Project (Number/Name)** C90 *I Advanced Distributed Simulation*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
training; and designed components in laboratory for real-time, physics-based terrain that replicated the operational environment and was distributed to support collective training for use in mobile devices and embedded systems. *FY 2015 Plans:* Develop the architecture for the Soldier-Centered Army Learning Environment (SCALE); investigate 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; complete and implement component designs of natural and man-made synthetic terrain effects such as craters, building rubble, etc.; and assess the training effectiveness of the attained levels of realism and immersion. The SCALE architecture will integrate mobile and social media technologies to enhance the training effectiveness of individual Soldiers. The architecture development will be consistent with the Army Learning Model (ALM). *FY 2016 Plans:* Will 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 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.			
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 2014 Accomplishments:* Researched enabling technologies for medical training combining appropriate fidelity, physiology, movement, and tissue (silicon vs. simulated biological structures), integrated and dissipated smells, sensors, varying pathologies, and fluids using an open	4.389	6.530	6.528

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 I 2	R-1 Program Element (Number/Name) PE 0602308A I *Advanced Concepts and Simulation*	Project (Number/Name) C90 I *Advanced Distributed Simulation*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
source, platform agnostic methodology; and designed hybrid position-navigation sensor to simulate electronic bullet to replace laser based system for live fire training. *FY 2015 Plans:* Continue 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; research, measure, and characterize real human and simulated human tissue to derive performance requirements for future simulated tissue; research embedded and external sensors to autonomously measure student performance inside and outside of the body; and investigate advanced 3-D visualization technologies and measure the impact on anatomical cognition for medical training. *FY 2016 Plans:* Will 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.			
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 2014 Accomplishments:* Conducted research to develop best practices for authoring computer-based tutoring systems (CBTS), managed instruction provided by CBTS, and assessed learning gains (e.g., knowledge and skill acquisition, retention and accelerated learning); researched learner modeling and instructional strategy/tactics selection by autonomous CBTS to reduce the cost to develop, deliver, and assess self-regulated training/tutoring for individuals and teams required under the Army Learning Model (ALM) for 2015; captured research results in the Generalized Intelligent Framework for Tutoring (GIFT) to promote standards and reuse; and conducted efficacy studies on virtual world and game based learning techniques for a blended learning approach to kinetic and non-kinetic training as well as human-unmanned systems teaming. *FY 2015 Plans:* Conduct research to develop best practices for automatically authoring, assessing, managing instruction, and deploying CBTS; design and develop domain models (e.g., content, human interaction, and assessment standards); determine effectiveness for CBTS technologies; develop techniques and identify technologies that will lower the skills required to author CBTS (per ALM); continue to incorporate research results in GIFT tutoring framework to enhance overall training effectiveness; conduct follow-on	6.173	5.202	5.189

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
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 2014	FY 2015	FY 2016
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:* Will 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.			
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 Plans:* Research and design a simulation architecture that supports the development of a Soldier as a System simulation; develop novel simulation solutions to link and synchronize models of human and system components; and establish 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:* Will 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; develop metrics to analyze design tradeoffs between factors such as individual and team performance, system effectiveness, training requirements and cost.	-	0.500	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 (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.	-	0.500	0.600

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602308A *I Advanced Concepts and Simulation*	**Project (Number/Name)** C90 *I Advanced Distributed Simulation*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
FY 2015 Plans: Research and develop simulation architectures that can represent current and future autonomous systems. The architectures will incorporate current autonomous system attributes that will enable the evaluation of their effects on individual and unit training.			
FY 2016 Plans: Will 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.			
Accomplishments/Planned Programs Subtotals	17.086	20.933	21.041

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 2016 Army												Date: February 2015	
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602308A *I Advanced Concepts and Simulation*						**Project (Number/Name)** D02 *I Modeling & Simulation For Training And Design*			
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**	
D02: *Modeling & Simulation For Training And Design*	-	6.278	6.490	6.821	-	6.821	7.099	5.428	6.525	6.655	-	-	

Note
 Not applicable for this item.

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 portfolio.

 Developed technologies and techniques are transitioned for maturation and demonstration to 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 U.S. Army Research Laboratory, Human Research and Engineering Directorate, Simulation and Training Technology Center (STTC), Orlando, FL.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Immersive Technology Environments	3.139	3.244	3.411

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 2014 Accomplishments:
Conducted studies to better understand how humans both perceive and interact with virtual environments; developed technologies for improved, low-cost immersive displays to reduce cost of training equipment and reduce the physical footprint needed for

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602308A *I Advanced Concepts and Simulation*	**Project (Number/Name)** D02 *I Modeling & Simulation For Training And Design*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
training facilities; enhanced small team training; and provided improved small unit leadership and capabilities using virtual environments. *FY 2015 Plans:* Research techniques for human spatial perception within virtual environment; investigate the effect of display configurations on social responses to virtual humans to increase immersive effects; and investigate outfitting displays with audio transducers and using psycho-acoustical effects methodologies to increase immersion and effectiveness during interactions with virtual humans. *FY 2016 Plans:* Will 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 (PTSD).			
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 2014 Accomplishments:* Determined how computer agents may be used to track a Soldier's career learning experiences and be used to provide training feedback and career guidance; finalized the development of a tool that automatically detects poorly synthesized segments of speech for the purpose of improving synthesized speech and dialogue for virtual humans; and finalized and implemented model that automatically adapts the dialogue intent recognition to each user. *FY 2015 Plans:* Research and evaluate situational authoring tools designed to enable non-technical users to create content for inclusion into intelligent tutoring systems; investigate new animation and natural language techniques for the development of web-based virtual humans to support on-line immersive learning environments; and explore techniques to rapidly recreate training scenario content. *FY 2016 Plans:* Will 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.	3.139	3.246	3.410
Accomplishments/Planned Programs Subtotals	6.278	6.490	6.821

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602308A *I Advanced Concepts and Simulation*	**Project (Number/Name)** D02 *I 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 2016 Army										**Date:** February 2015		

Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602601A *I Combat Vehicle and Automotive Technology*

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
Total Program Element	-	63.476	72.861	68.839	-	68.839	69.739	68.527	62.971	64.293	-	-
C05: *Armor Applied Research*	-	26.220	31.399	29.251	-	29.251	28.414	26.121	20.850	21.354	-	-
H77: *National Automotive Center*	-	14.815	15.636	15.738	-	15.738	15.936	16.219	16.322	16.642	-	-
H91: *Ground Vehicle Technology*	-	22.441	25.826	23.850	-	23.850	25.389	26.187	25.799	26.297	-	-

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. 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, 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 U.S. 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.

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army				Date: February 2015	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*			**R-1 Program Element (Number/Name)** PE 0602601A *I Combat Vehicle and Automotive Technology*		

B. Program Change Summary ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Previous President's Budget	64.555	72.883	69.342	-	69.342
Current President's Budget	63.476	72.861	68.839	-	68.839
Total Adjustments	-1.079	-0.022	-0.503	-	-0.503
• Congressional General Reductions	-	-0.022			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-0.006	-			
• SBIR/STTR Transfer	-1.073	-			
• Adjustments to Budget Years	-	-	-0.503	-	-0.503

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army										Date: February 2015	

Appropriation/Budget Activity
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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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
C05: Armor Applied Research	-	26.220	31.399	29.251	-	29.251	28.414	26.121	20.850	21.354	-	-

Note
Not applicable for this item.

A. Mission Description and Budget Item Justification

This project investigates, researches, and evaluates advanced ground vehicle design and occupant protection technologies in such areas as armor concepts, ballistic defeat mechanisms, blast mitigation, survivability modeling and simulation (M&S), improved situational awareness, hit avoidance, kill avoidance, safety, sensors for blast, crash and rollovers, instrumentation and survivability packaging concepts to achieve superior survivability/protection for Soldiers and ground combat and tactical vehicles. Survivability/protection technologies are being investigated to meet anticipated ground combat and tactical vehicle survivability objectives. Additionally, this project focuses on analysis, modeling, and characterization of potential survivability solutions that could protect against existing and emerging threats. This analysis is used to aid in the identification of technologies to enter maturation and development in PE 0603005A, 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 2014	FY 2015	FY 2016
Title: Advanced Armor Development:	10.915	15.855	12.744
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) and multifunctional armor.			
FY 2014 Accomplishments:			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 I 2	R-1 Program Element (Number/Name) PE 0602601A I Combat Vehicle and Automotive Technology	Project (Number/Name) C05 I Armor Applied Research

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Provided initial characterization of next generation advanced lightweight combat vehicle armors for identification of future armor maturation risk; conducted initial performance and cost trade analysis on the integration of advanced armor technologies; and performed environmental and ballistic testing on vehicle size armor coupons for system level integration. *FY 2015 Plans:* Continue characterization of next generation advanced lightweight combat and tactical vehicle armors; perform 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); perform risk mitigation and integration analysis for combat vehicle threat-based passive, reactive and electromagnetic chemical energy armor systems (C-Kits); explore 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%. Will 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. Will conduct advanced passive kinetic energy armor and explosive reactive armor integration experiments for component integration, and system seams and attachments. Will begin validation of advanced passive kinetic energy armor systems (B-Kits), and advanced reactive armor systems for chemical energy threats (C-Kits) by conducting ballistic experiments. Will mature lightweight materials for structural application and structural designs to provide the protection capability required when integrated with B-Kit and C-Kit armor.			
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, modeling and simulation (M&S), experimentation and instrumentation. *FY 2014 Accomplishments:* Researched innovative approaches and improved occupant protection capabilities, in mitigating underbody blast, crash and rollover injuries in areas such as seats, restraints, protective trim, hull structures, and energy absorbing materials and approaches; refined and employed modeling and simulation (M&S) tools for assessing occupant protection technologies; developed laboratory tools to better assess integrated components, sub-system and system level responses for protection of Soldiers in underbody	11.003	9.284	6.541

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602601A *I Combat Vehicle and Automotive Technology*	**Project (Number/Name)** C05 *I Armor Applied Research*	

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
blast, crash and rollover events; leveraged and expanded on defense, automotive and medical community efforts for improving vehicle exterior, interior and sensor capabilities; continued incorporating lessons learned into occupant protection standards and guidelines; and advanced instrumentation capabilities such as anthropometric test devices and blast data collection for research.			
FY 2015 Plans: Research and conduct 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; conduct 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; verify and validate occupant-centric design guidelines/standards, M&S tools, test procedures, laboratory processes, experimentation capabilities; research means to allow mechanical countermine tactics or products to be more effective; support 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: Will develop blast mitigation technologies to include seats, restraints, flooring and structures at the component and sub-system level to verify sub-system interactions. Will 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. Will verify component and sub-system design guidelines and evaluation techniques. Will mature the Warrior Injury Assessment Manikin (WIAMan) in the laboratory environment through durability, repeatability and sensitivity tests of the WIAMan device components and system. Will begin development of WIAMan test device certification procedures through 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 2014 Accomplishments:* Provided rapid organization and assessment of threat/countermeasure interaction reducing the overall burden on systems; designed and developed modeling and simulation capability to optimize vehicle protection; designed modeling capabilities to represent blast technologies for tradeoff analysis; provided quick reaction capability to quantify platform baseline survivability and prioritize enhancements. *FY 2015 Plans:*	4.302	3.253	1.000

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602601A *I Combat Vehicle and Automotive Technology*	**Project (Number/Name)** C05 *I Armor Applied Research*	

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Provide 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; provide enhanced assessment methodologies for quantifying and mitigating post-engagement damage and crew casualties from effects such as blast and fire; and provide enhanced assessment methodologies for mobility and survivability on protected mobility. *FY 2016 Plans:* Will 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.			
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 Plans:* Conduct initial investigation of video and data architectures that enable the efficient integration of degraded visual environment (DVE) situational awareness (SA) technologies; Conduct 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:* Will integrate aviation-based degraded visual environment (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.	-	3.007	7.040
Title: Vision Protection *Description:* This effort investigates and develops protection materials, concepts, and devices to protect vehicle occupants' eyes, vehicle cameras and electro-optical fire control systems against emerging laser threats. This effort also evaluates methods to apply the advanced protection materials, concepts, and devices onto vehicle cameras and electro-optical systems to prevent	-	-	1.926

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602601A *I Combat Vehicle and Automotive Technology*	**Project (Number/Name)** C05 *I Armor Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
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:* Will conduct damage threshold and damage mechanism studies on current day cameras and optical systems from short-pulsed laser threats. Will also improve capability to conduct experiments and validation of protection concepts against emerging laser threats.			
Accomplishments/Planned Programs Subtotals	26.220	31.399	29.251

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 2016 Army										Date: February 2015	
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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
H77: *National Automotive Center*	-	14.815	15.636	15.738	-	15.738	15.936	16.219	16.322	16.642	-	-

Note
 Not applicable for this item.

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 2014	FY 2015	FY 2016
Title: Power, Energy and Mobility:	4.024	4.234	4.236
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 PEs 0603005A and 0603125A.			
FY 2014 Accomplishments: Continued to partner with other government agencies such as the Department of Energy (DOE) through cooperative alliances such as the Advanced Vehicle Power Technology Alliance (AVPTA); continued to support the transition of technology to/from industry and government; leveraged both industry and government facilities for evaluation, integration and testing; developed new manufacturing processes and material technologies to reduce platform weight through lightweight composite materials and novel			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602601A *I Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H77 *I National Automotive Center*	

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
material joining; continued to pursue collaborations with industry and university partners to develop dual use, energy efficient, automotive technologies. *FY 2015 Plans:* Collaborate 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. Perform next generation of joint activities under the AVPTA vehicle efficiency alliance with the Department of Energy. Develop modeling and simulation of advanced vehicle technologies with DOE AVPTA activities. Investigate energy efficient lubrication potential to produce a significant savings in overall fuel efficiency for our fleets. This work is being coordinated with PE 0603125A. *FY 2016 Plans:* Will continue joint activities with Department of Energy and Department of Transportation to exploit fuel efficient vehicle operation for military platforms and duty cycles. Will continue to support the transition of technology to/from industry and government. Will develop and mature fuel cell systems for initial integration experiments of fuel cells onto vehicles. Will investigate fuel reduction and water generation technologies to determine logistical impacts, leveraging commercial and academic investments.			
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 2014 Accomplishments:* Continued to identify, pursue, and leverage dual use technical opportunities with both military and industry application through active partnering with industry/academia/other government agencies as well as other consortiums/forums/alliances and associations such as the Hybrid, Electric and Advanced Truck Users Forum; continued to focus on technologies that will help solve vehicle and installation energy problems; continued University applied research in areas including off-road vehicle dynamics and controls, soldier/vehicle interaction modeling, high-performance/lightweight structures and materials, alternative propulsion systems, advanced thermal management, and vehicle system design optimization for reliability and robustness. *FY 2015 Plans:* Continue 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 include component safety, human interface and distracted driving	10.791	11.402	11.502

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602601A *I Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H77 *I National Automotive Center*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
technologies. Proceed to leverage the commercial automotive and trucking research and development centers at the OEM and tier suppliers to bring reliable, affordable technology solutions to our military ground vehicle fleet. *FY 2016 Plans:* Will continue to leverage commercial automotive and trucking research and development centers to transition reliable, affordable technology solutions to our military ground vehicle fleet. Will continue to leverage industry's state of the art vehicle electrification and open vehicle architecture standards and facilitate transition into military ground vehicles. Will continue to research and develop autonomous vehicle standards with industry and other government organizations. Will mature intelligent ground vehicle systems and develop mission payloads for dual use applications to increase effidences. Will investigate solutions to transition commercial fuel cell technologies to military ground systems.			
Accomplishments/Planned Programs Subtotals	14.815	15.636	15.738

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 2016 Army										**Date:** February 2015	
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602601A *I Combat Vehicle and Automotive Technology*						**Project (Number/Name)** H91 *I Ground Vehicle Technology*	

COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
H91: *Ground Vehicle Technology*	-	22.441	25.826	23.850	-	23.850	25.389	26.187	25.799	26.297	-	-

Note
 Not applicable for this item.

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 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 U.S. Army Engineer Research and DevelopmentCenter, Edgewood Chemical Biological Center (ECBC), and the Army Medical Department.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Title: Pulse Power:	0.958	3.369	3.423
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 PEs 0603005A and 0602705A. *FY 2014 Accomplishments:* Performed component development of advanced electrified armor components, and directed energy systems components related to survivability and lethality including high voltage solid state devices and high energy density capacitors. Continued component development to decrease space, volume and thermal requirements while increasing performance. *FY 2015 Plans:*			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602601A *I Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 *I Ground Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Fabricate 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. Conduct road testing and soldier-in-the-loop testing with electrified armors for safety and performance validation. *FY 2016 Plans:* Will complete the design and integration of energy storage and high-voltage power electronic components into a system that enables high mass-efficiency electro-magnetic threat defeat mechanisms. Will begin pulse power system laboratory testing to validate the power system performance needed for electromagnetic armor threat defeat. Will complete design of an electromagnetic armor module.			
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), increased electrical power generation needs (onboard communications, surveillance and exportable power), improved fuel economy (fuel cost & range), enhanced mobility (survivability), 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 063005A. *FY 2014 Accomplishments:* Investigated and created concepts for 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. Developed an advanced fan design to provide for a more efficient cooling capability for the engine to increase the overall system capability. *FY 2015 Plans:* Investigate waste heat recovery applications for military vehicles to increase system efficiencies. Investigate grill designs for greater cooling capability. Design and fabricate 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:*	3.046	4.465	5.122

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
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 2014	FY 2015	FY 2016
Will design and develop an advanced heat exchanger and efficient fan subsystem to increase cooling capabilities and fuel efficiency. Will design waste heat recovery system for military vehicle applications to provide additional onboard electrical power. Will mature engine component concept designs through thermal, structural and reliability modeling and simulation.			
Title: Power Management Technologies: *Description:* This effort investigates power management technologies, software, and implementation approaches. Technologies include Alternating Current (AC) to Direct Current (DC) inverters, DC-DC converters, solid state circuit protection, power distribution, and automated control of complete power systems. Special emphasis has been placed on developing high temperature capable power electronics, leading to the use of Silicon Carbide (SiC) in the above technologies. This effort coordinates with PE 0603005A. *FY 2014 Accomplishments:* Designed and developed Silicon Carbide-based power electronics for power conversion, distribution, and control in order to implement the next generation, open, non-proprietary electrical power architecture for military ground vehicles and merge previous power management developments with architectural developments to support demonstration of fuel savings (at least 10% on a 72-hour combat mission) power management brings when combined with an advanced electrical power architecture. *FY 2015 Plans:* Test 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. Continue development of the power management algorithms and software for the next generation power architecture. Demonstrate power management and advanced electrical power architecture fuel savings gains of at least 10% on a 72-hour combat mission. Begin 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:* Will complete development of the next generation power architecture and corresponding system design using SiC power electronics and low cost computers. Will integrate high and low voltage power components into a system integration laboratory (SIL) and will conduct validation of the power architecture and power electronics in the SIL, demonstrating SiC and automated power management.	1.898	2.823	2.583
Title: Power Electronics, Hybrid Electric and Onboard Vehicle Power (OBVP) Components: *Description:* This effort researches, develops and evaluates technologies to increase onboard vehicle electric power to enable vehicle systems such as advanced survivability systems, situational awareness systems, advanced computing, and the Army network. This effort researches, designs and evaluates high temperature and efficient power generation components to provide increased electrical power and reduced thermal loads using high operating temperature switching devices and advanced electrical	2.409	1.328	1.218

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602601A *I Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 *I Ground Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
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. *FY 2014 Accomplishments:* Investigated vehicle efficiency, space and weight impacts of OBVP generation in a system laboratory that includes the vehicle power pack and supporting auxiliary systems; compared OBVP system performance versus the performance of a conventional system; investigated the potential controls strategy enhancements of system operation where speed/power of auxiliary systems are easily manipulated; investigated vehicle level benefits (efficiency, space, weight, ambient temperature operating range) of high temperature power electronics versus traditional power electronics for power generation. *FY 2015 Plans:* Investigate approaches to further electrify and control parasitic vehicle automotive loads and increase efficiency; model and simulate tracked vehicle performance with OBVP technologies integrated; investigate approaches to implement mild hybrid (system that integrates electric machines to assist internal combustion engines for propulsion) capabilities on OBVP equipped vehicles. Investigate intelligent engine start/stop strategy, architecture and controls to dramatically reduce engine idling. *FY 2016 Plans:* Will 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.			
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 2014 Accomplishments:* Investigated engine based 10 kilowatt (kW) Auxiliary Power Unit (APU) oil consumption reduction technologies in order to decrease maintenance intervals and increase reliability; conducted experiments on acoustic treatments for engine based APUs; conducted sulfur tolerant JP-8 reformer experiments; and conducted initial assessment of fuel cell-based APU solutions. *FY 2015 Plans:*	3.103	3.052	1.909

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602601A *I Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 *I Ground Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Investigate technologies that would enable a 20kW fuel cell APU; beginning initial experiments on increasing fuel cell components resistance to sulfur; beginning initial experiments of high power rotary engine APU designs; beginning to investigate noise mitigation solutions for high power rotary engine APUs. *FY 2016 Plans:* Will 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. Will investigate and design active noise control, muffler and insulation technologies to reduce the acoustic signature of engine-based auxiliary power units (APU) to decrease 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 2014 Accomplishments:* Expanded integration of short fibers into elastomer compounds to augment durability and increase abrasion resistance; fabricated American Society for Testing and Materials (ASTM) samples and performed laboratory evaluation of short fiber infused elastomer coupons to determine material property improvements; and fabricated vehicle test articles and performed on-vehicle testing to validate laboratory based improvements to material compound changes. *FY 2015 Plans:* Perform analysis of previously tested short fiber materials; optimize fiber orientation and validate through laboratory testing; analyze the potential of combining short fiber material with novel other fillers to further reduce black carbon in the elastomer material; perform laboratory testing of optimized compounds. *FY 2016 Plans:* Will fabricate elastomer samples with optimized compounds for durability evaluation. Will validate durability evaluation data with predictive fatigue models. Will perform design iterations of track system elastomer components based on field test results and fatigue modeling and simulation.	0.986	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,	6.522	7.592	6.614

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army			Date: February 2015
Appropriation/Budget Activity 2040 *I* 2		**R-1 Program Element (Number/Name)** PE 0602601A *I Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 *I Ground Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
vehicle and pedestrian safety, active safety, and robotic command and control. This effort is coordinated with efforts in PEs 0602120A and 0603005A *FY 2014 Accomplishments:* Developed advance active safety systems to include controls, algorithms and associated hardware onto manned/unmanned wheeled vehicles; increased performance of perceptive sensors and planning algorithms and integrated on to robotic platforms for safe operations in dynamic environments; and refined tactical behaviors for mission execution on robotic platforms. *FY 2015 Plans:* Extend the capabilities of active safety systems for military vehicles to reduce soldier injury due to vehicle accidents and rollovers; advance capabilities for manned/unmanned teaming; enhance command and control software to enable single-operator control of multiple unmanned systems; refine algorithms, sensor fusion, dismounted behaviors, and soldier-robot interaction capabilities to enable mission planning and execution in dynamic environments; further development of interoperability profiles and mission package integration; develop capabilities for longer-duration/higher-tempo operations. *FY 2016 Plans:* Will develop autonomous behaviors for mounted and dismounted ground vehicle systems that are adaptable to different missions and environments. Will develop advanced cognitive control through feedback coupling of Soldier-Unmanned Ground Vehicle system capabilities and behavior at neural, neurocognitive, and sociocognitive levels. Will 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.			
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 2014 Accomplishments:*	2.378	2.535	2.319

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602601A *I Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 *I Ground Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Conducted initial experiments to validate performance of novel materials (anode, cathode, electrolyte, and separators) for cell and battery module (series of cells in series or parallel) with improved energy density and power density in the same form factor as the existing batteries for extended silent watch durations. *FY 2015 Plans:* Integrate novel battery materials (anode, cathode, electrolyte, and separators) into battery cells designed to fit into existing military battery form-factors (ex: 6T); improve 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); improve 6T battery designs for manufacturability, commonality and cost reduction; validate improved 6T designs against latest battery & vehicle safety and performance requirements. *FY 2016 Plans:* Will design and develop advanced cell level materials to fit into standardized military battery form factors such as 6T. Will design improved advanced standardized battery prototypes by incorporating advanced cell materials. Will develop and mature electrochemical cell designs to improve energy density, starting, lighting, propulsion system ignition, silent watch and reliability of military specific battery.			
Title: Petroleum, Oil, and Lubricant (POL) Products: *Description:* This project focuses on creating and evaluating innovative petroleum, oil and lubricant (POL) products that reduce logistic burdens, maintenance requirements, and fuel consumption. Products will be developed in areas such as alternative fuels, fuel additives, lubricants, power train fluids, coolants, and petroleum, oil, and lubricant products to support new military technology requirements such as anti-lock brakes and semi-active suspension. *FY 2014 Accomplishments:* Identified candidate fuel efficient gear lubricants and hydraulic fluids to improve ground system performance and reduce logistics burden; evaluated new alternative fuels and fuel additives that may improve performance and diversify energy sources; and identified candidate POL products with high potential to meet new military technology requirements while ensuring legacy equipment performance and technical requirements are maintained.	1.141	-	-
Accomplishments/Planned Programs Subtotals	22.441	25.826	23.850

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

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D. Acquisition Strategy

 N/A

E. Performance Metrics

 N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army											Date: February 2015	

Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*				R-1 Program Element (Number/Name) PE 0602618A *I Ballistics Technology*								

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
Total Program Element	-	73.906	85.575	92.801	-	92.801	87.540	89.915	90.850	93.226	-	-
H80: *Survivability And Lethality Technology*	-	67.139	85.575	92.801	-	92.801	87.540	89.915	90.850	93.226	-	-
HB1: *SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)*	-	6.767	-	-	-	-	-	-	-	-	-	-

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 U.S. Army Research Laboratory (ARL), Aberdeen Proving Ground, MD.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army				Date: February 2015	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*			**R-1 Program Element (Number/Name)** PE 0602618A I *Ballistics Technology*		
B. Program Change Summary ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**
Previous President's Budget	75.263	85.597	93.967	-	93.967
Current President's Budget	73.906	85.575	92.801	-	92.801
Total Adjustments	-1.357	-0.022	-1.166	-	-1.166
• Congressional General Reductions	-	-0.022			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.357	-			
• Adjustments to Budget Years	-	-	-1.166	-	-1.166

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2014**	**FY 2015**
Project: HB1: *SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)*		
Congressional Add: *Program Increase*	6.767	-
Congressional Add Subtotals for Project: HB1	6.767	-
Congressional Add Totals for all Projects	6.767	-

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army										Date: February 2015	

Appropriation/Budget Activity 2040 I 2				R-1 Program Element (Number/Name) PE 0602618A I Ballistics Technology					Project (Number/Name) H80 I Survivability And Lethality Technology		

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
H80: *Survivability And Lethality Technology*	-	67.139	85.575	92.801	-	92.801	87.540	89.915	90.850	93.226	-	-

Note
 Not applicable for this item.

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 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 U.S. Army Research Laboratory (ARL), Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Underbody Blast & Occupant Protection	6.083	6.550	5.314
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. *FY 2014 Accomplishments:* Introduced advanced modeling tools developed under the Ballistic and Blast Loading Highly Scalable Software Institute to develop strongly hardened hull designs; and matured long-stroke technology and multi-directional seating mechanisms to further enhance interior protection along with an appropriate sensor suite for pre-activation of active seat or exterior hull mechanisms. *FY 2015 Plans:*			

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
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 2014	FY 2015	FY 2016
Continue to develop experimental and modeling approaches to identify relevant physical parameters affecting the loading from buried blast and penetrator threats; develop experimental tools to track complex occupant motion during a blast event and validate associated numerical models; and develop and validate momentum transfer concepts to absorb energy from underbody threats through a combination of materials development and structural design research. *FY 2016 Plans:* Will investigate structural damage and response due to buried blast and penetrator threats and propose novel protection solutions to defeat these threats; develop active mechanisms including momentum transfer and other technologies to mitigate lower-extremity injuries.			
Title: Low Cost Hyper-Accuracy Munition Technologies	4.903	3.048	3.812
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 2014 Accomplishments:* Implemented new optimal terminal homing guidance laws and flight control algorithms in simulation code; conducted parametric studies across a range of attack angles to quantify resulting control effectiveness to more cost effectively and accurately hit targets; and performed lab, wind tunnel and soft launch experiments to investigate lifting surface control mechanisms and lateral & axial thrusters especially at high angles of attack. *FY 2015 Plans:* Advance 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 assess concepts using multiple technologies for guided munitions in global positioning system (GPS) denied environments. *FY 2016 Plans:* Will 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.			
Title: Disruptive Energetics and Propulsion Technologies	6.365	10.280	10.538
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.			

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
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 2014	FY 2015	FY 2016
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 2014 Accomplishments:* Synthesized two new energetic compounds (binder and explosive) that exhibit increased energy compared to current carbon, hydrogen, nitrogen and oxygen (CHNO) compounds; experimentally quantified their performance with a small scale technique that cost effectively requires only grams (compared to current kilogram technique); and evaluated propellant improvements for small arms ammunition. *FY 2015 Plans:* Explore and exploit innovative methods for efficient synthesis and scale-up of disruptive energetic materials; develop novel energetic ingredients using chemical and high pressure synthesis methods; use these ingredients in new formulations for transition to weapons applications with significantly improved performance; develop multi-phase explosive and initiation concepts to maximize energy transfer to target; develop and validate numerical model of muzzle flow field in small caliber weapon systems to enable control of overpressure; and validate 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:* Will 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; develop 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 develop 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.			
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 2014 Accomplishments:* Conducted proof-of-principle experiments for man-portable weapons that validated capability to perforate wall targets including double reinforced concrete and adobe; experimentally investigated and quantified performance improvements of chemical energy weapons when nano-crystalline materials (e.g., copper and tungsten) were used; conceptualized variations in novel penetrator deployment schemes and conducted laboratory experiments to understand how deployment variations affect lethality	5.505	6.517	5.691

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602618A *I Ballistics Technology*	**Project (Number/Name)** H80 *I Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
performance; and incorporated an optimized multi-component/jacketed shearing composite penetrator into a large caliber cartridge to examine its lethality. *FY 2015 Plans:* Develop small caliber soldier-portable mechanisms to defeat combatants in high-risk urban scenarios; validate 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 validate modeling and simulation capabilities to assess novel lethality concepts. *FY 2016 Plans:* Will 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 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.			
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 2014 Accomplishments:* Developed new methodologies to characterize Personnel Protective Equipment armor back face deformation and assessed the associated injury incapacitation probabilities for soldiers; performed improvements to tools, techniques, and methodologies for ballistic survivability/lethality analysis to ensure analysis tools are relevant and credible for developmental and modernized Army systems; and conducted validation and verification of the Modular Unix-based Vulnerability Estimation Suite (MUVES) 3 ballistic vulnerability and lethality code. *FY 2015 Plans:* Develop new methodologies to characterize behind helmet blunt trauma and assess the associated injury incapacitation probabilities for soldiers; develop predictive ammunition vulnerability methodologies (vulnerability to unintended ammunition detonation due to incoming round); perform improvements to tools, techniques, and methodologies for ballistic survivability/lethality analysis to ensure analysis tools are relevant and credible for developmental and modernized Army systems; and conduct validation and verification of ballistic vulnerability and lethality codes. *FY 2016 Plans:* Will 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	9.871	12.566	10.202

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
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.			
Title: Multi-Threat Armor Formulations and Designs	17.764	20.953	23.188
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. *FY 2014 Accomplishments:* Developed ceramic laminate technology, large improvised threat protection, and second generation multi-threat protection; supported transition to the U.S. Army TARDEC (PE 0602601A /Project C05); used modeling and simulation coupled with experimentation to explore encapsulated ceramic mechanisms capable of defeating more advanced kinetic energy (KE) threats; and began exploration and concept development of novel adaptive protection. *FY 2015 Plans:* Investigate ceramic laminate characteristics to identify/gain iterative improvements for protection during future threat/ armor engagement processes; investigate concepts for defeat of very large shaped charge threats, including developing an understanding of how various defeat mechanisms interact as threat size increases; explore novel explosive reactive armor mechanisms for defeat of advanced threats; develop new approaches for advanced KE multi-hit defeat for vehicle sides and front; validate protection capabilities against both explosively formed penetrators (EFPs) and rocket propelled grenades (RPGs) by utilizing multiple defeat mechanisms in a single system; develop new mechanisms to enable defeat of both KE and chemical energy (CE) threats in a single system; and support transitions to the U.S. Army TARDEC PE 0602601A/Project C05and PE 0603005A /Project 441). *FY 2016 Plans:* Will 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.			
Title: Ballistic and Blast Protection for Dismounted Soldiers	3.055	3.059	3.758
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 of this knowledge framework to develop low technology readiness level (TRL) PPE concepts that are informed by the human effects during impact and blast events.			

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Appropriation/Budget Activity 2040 I 2	**R-1 Program Element (Number/Name)** PE 0602618A I *Ballistics Technology*	**Project (Number/Name)** H80 I *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
FY 2014 Accomplishments: Developed techniques for understanding the response of biologic materials at high rates of loading that cause severe deformation and failure; and explored low TRL concepts for PPE that were based on computational simulations of the interaction of humans with the dynamic threat/PPE impact. *FY 2015 Plans:* Develop an objective blunt trauma test methodology for helmets using a combination of experimental and modeling approaches, exploring relationships to injury mechanisms; and explore the use of covers and surface coatings on ceramic performance for monolithic and flexible body armor concepts. *FY 2016 Plans:* Will 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.			
Title: Penetrator Lethality Applied Research *Description:* This effort evaluates effects of velocity and novel penetrator designs for future lethality applications across the spectrum of targets to include vehicles, buildings, and personnel. (In FY15 this effort transfers to Lethal and Scalable Effects Technologies) *FY 2014 Accomplishments:* Conducted lethality analysis (i.e., probability of kill given a target hit) across the velocity spectrum for novel penetrator concepts.	2.060	-	-
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 2014 Accomplishments:* Investigated alternate approaches to increase long range precision and improve probability of incapacitation for sniper and small arms applications. *FY 2015 Plans:*	2.943	3.477	3.299

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015
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 2014	FY 2015	FY 2016
Pursue novel concepts to enable significant increases in impact velocities, reduced muzzle pressures, and increased accuracy in small caliber systems; and develop understanding of alternate approaches to achieve long range precision for 50 caliber man-portable systems. *FY 2016 Plans:* Will continue to investigate concepts and validate models to achieve significantly higher muzzle velocities in small caliber weapons; and develop 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.			
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, U.S. Army Medical Research and Materiel Command (MRMC) to U.S. ARL effective FY15. *FY 2014 Accomplishments:* Completed technical data package for the design concept for a first generation, WIAMan demonstrator; began fabrication of the first generation WIAMan demonstrator and initiated manufacturing and component testing; developed new methods for injury prediction and spun-out knowledge to benefit on-going Live Fire Test & Evaluation programs; and defined concept for WIAMan data acquisition system. *FY 2015 Plans:* Initiate validation and verification testing of the first generation WIAMan demonstrator; design and initiate development of the WIAMan data acquisition system; transfer knowledge and tools for use in Live Fire Test & 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; and transfer of responsibilities and funding (PE 0602787A/project 869) from U.S. Army Medical Research and Materiel Command (MRMC) to U.S. 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	5.150	10.500	11.393

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602618A *I Ballistics Technology*	**Project (Number/Name)** H80 *I Survivability And Lethality Technology*	

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
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.			
Title: Vulnerability Assessment of Technologies *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 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 2014 Accomplishments:* Designed and conducted experiments on developmental communications technologies (Multiple-Input and Multiple-Output (MIMO), Dynamic Spectrum Access, and Ultra-Wideband) to identify potential technology vulnerabilities through brute force and smart jamming approaches, spoofing, malicious code, and device discovery exploitation; determined mitigation options to address demonstrated technology vulnerabilities. *FY 2015 Plans:* Select developmental (current and emerging) technologies; identify spectrum of threats for technologies identified and select high-priority threats for investigation; design, develop and mature assessment methods and tools; design and conduct experiments that will demonstrate technology vulnerabilities; and identify mitigation strategies for any vulnerabilities discovered. Technology selection will be 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 design assessments with environments and factors that may be used to demonstrate vulnerabilities (electronic warfare, cyber security, survivability, lethality and system of systems). Candidates and technologies to investigate include 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 might benefit from reduction of optical augmentation. *FY 2016 Plans:* Will conduct vulnerability assessments on critical 6.2 technologies based on Army priorities. These assessments will identify very early-on, possible vulnerabilities and shortcomings of emerging technologies and will influence future S&T investment decisions resulting in the fielding of more robust systems. Candidate technologies will be considered across all Army S&T portfolios.	3.440	4.500	8.630
Title: Active Protection Modeling and Technologies	-	4.125	6.976

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602618A *I Ballistics Technology*	**Project (Number/Name)** H80 *I Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Description: This effort supports the development of Active Protection System (APS) technologies and common architecture to reduce vehicle weight while significantly increasing protection against current and emerging advanced threats by reducing reliance on armor through other means such as sensing, warning, and active countermeasures. The APS common architecture will provide adaptable APS solutions that can be integrated across Army vehicle platforms as required. This research includes the development of new modeling and simulation capabilities along with supporting experimental and theoretical approaches to enable active protective systems. This effort includes integrated information (e.g., battlefield geography, threat launch detection and tracking) and intelligence to inform protection optimization, requiring collaboration across multiple Army organizations. 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 Plans:* Explore threat independent hybrid/adaptive mechanisms; develop and validate initial computational model to examine interactions of sensors and defeat mechanisms against ballistic threats; and develop active protection concepts, including countermeasures, threat warning capabilities, and dynamic threat maps. *FY 2016 Plans:* Will develop Anti-Tank Guided Missile (ATGM) flight models; conduct warhead damage experiments into larger threats with different warhead explosives; develop softkill countermeasure models; complete integrate softkill and hardkill components and controller algorithms into an overarching softkill/hardkill simulation; integrate results into RDECOM-level APS simulations suite.			
Accomplishments/Planned Programs Subtotals	67.139	85.575	92.801

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army											**Date:** February 2015	
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602618A *I Ballistics Technology*						**Project (Number/Name)** HB1 *I SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)*		

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
HB1: *SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)*	-	6.767	-	-	-	-	-	-	-	-	-	-

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 2014**	**FY 2015**
Congressional Add: Program Increase	6.767	-
FY 2014 Accomplishments: Program Increase for the WIAMan effort.		
Congressional Adds Subtotals	6.767	-

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army											Date: February 2015	

Appropriation/Budget Activity	R-1 Program Element (Number/Name)
2040: Research, Development, Test & Evaluation, Army I BA 2: Applied Research	PE 0602622A I Chemical, Smoke and Equipment Defeating Technology

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
Total Program Element	-	4.378	3.970	3.866	-	3.866	3.923	3.994	4.018	4.098	-	-
552: Smoke/Novel Effect Mun	-	4.378	3.970	3.866	-	3.866	3.923	3.994	4.018	4.098	-	-

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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Previous President's Budget	4.487	3.971	3.894	-	3.894
Current President's Budget	4.378	3.970	3.866	-	3.866
Total Adjustments	-0.109	-0.001	-0.028	-	-0.028
• Congressional General Reductions	-	-0.001			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.109	-			
• Adjustments to Budget Years	-	-	-0.028	-	-0.028

PE 0602622A: Chemical, Smoke and Equipment Defeating ...
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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army										Date: February 2015	

Appropriation/Budget Activity 2040 I 2	R-1 Program Element (Number/Name) PE 0602622A I Chemical, Smoke and Equipment Defeating Technology	Project (Number/Name) 552 I Smoke/Novel Effect Mun

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
552: Smoke/Novel Effect Mun	-	4.378	3.970	3.866	-	3.866	3.923	3.994	4.018	4.098	-	-

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 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 2014	FY 2015	FY 2016
Title: Advanced Obscurants	1.438	1.504	1.426

Description: This effort investigates new materials and compounds to enable safe, effective screening of personnel and equipment.

FY 2014 Accomplishments:
Investigated spectrally selective obscuration concepts to provide Warfighter with a new one-way smoke capability; investigated microwave obscurant formulations to defeat future electronic warfare (EW) threats.

FY 2015 Plans:
Continue to investigate spectrally selective materials and new microwave obscurant materials.

FY 2016 Plans:

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 I 2	**R-1 Program Element (Number/Name)** PE 0602622A I Chemical, Smoke and Equipment Defeating Technology	**Project (Number/Name)** 552 I Smoke/Novel Effect Mun

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Will continue to investigate spectrally selective materials and new microwave materials. Investigate materials for advanced bispectral obscurants.			
Title: Obscurant Enabling Technology	1.000	1.000	1.000
Description: This effort investigates distribution technologies for various obscurants. **FY 2014 Accomplishments:** Continued dissemination studies of new low hazard visual obscurants for grenade applications; conducted novel modeling analysis of new low hazard obscurants for mortar/artillery applications dissemination studies. **FY 2015 Plans:** Continue to study dissemination of new low hazard visual obscurants for grenade applications. Will initiate explosive dissemination technology studies. Will initiate efforts to investigate vulnerability of various technologies to obscurant/target defeat effects. Will identify technologies of interest; conduct initial analysis with the intent of evaluating/assessing effects. **FY 2016 Plans:** Will continue to study explosive dissemination variables to understand key factors such as obscurant dispersal. Will continue to conduct vulnerability studies of various technologies to obscurant/target defeat effects.			
Title: Forensic Analysis of Explosives	1.940	1.466	1.440
Description: This effort investigates forensics analytical methods for military explosives, homemade explosives (HME), HME precursors, and residue analysis for attribution. **FY 2014 Accomplishments:** Developed analytical methods for forensic analysis of explosives with the objective of assigning attribution to include collection, preparation, instrumental analysis and advanced statistical techniques; provided solutions for analytical problems encountered by expeditionary laboratories, particularly for the analysis of explosives (Toxic Industrial Compounds (TICs), and Materials(TIMs), agricultural chemicals and emerging needs and threats) in a variety of sample matrices. **FY 2015 Plans:** Investigate linkages of spectroscopic signatures developed in FY12 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:**			

PE 0602622A: *Chemical, Smoke and Equipment Defeating ...*
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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602622A *I Chemical, Smoke and Equipment Defeating Technology*	**Project (Number/Name)** 552 *I Smoke/Novel Effect Mun*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Will 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.			
Accomplishments/Planned Programs Subtotals	4.378	3.970	3.866

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

PE 0602622A: *Chemical, Smoke and Equipment Defeating ...*
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Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army											Date: February 2015	

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

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
Total Program Element	-	7.592	6.850	5.487	-	5.487	5.545	5.608	5.565	5.675	-	-
H21: *Jt Svc Sa Prog (JSSAP)*	-	7.592	6.850	5.487	-	5.487	5.545	5.608	5.565	5.675	-	-

A. Mission Description and Budget Item Justification

This program element (PE) investigates designs and evaluates individual and crew-served weapon 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 US 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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Previous President's Budget	7.814	6.853	5.527	-	5.527
Current President's Budget	7.592	6.850	5.487	-	5.487
Total Adjustments	-0.222	-0.003	-0.040	-	-0.040
• Congressional General Reductions	-	-0.003			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.222	-			
• Adjustments to Budget Years	-	-	-0.040	-	-0.040

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army										Date: February 2015	
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602623A *I Joint Service Small Arms Program*					**Project (Number/Name)** H21 *I Jt Svc Sa Prog (JSSAP)*		

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
H21: *Jt Svc Sa Prog (JSSAP)*	-	7.592	6.850	5.487	-	5.487	5.545	5.608	5.565	5.675	-	-

A. Mission Description and Budget Item Justification

This project investigates designs and evaluates individual and crew-served weapon component 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 support the Soldier Science and Technology 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 US Army Armament Research, Development, and Engineering Center (ARDEC), Picatinny, NJ.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Advanced Small Unit (Squad) Small Arms Technology Concepts	3.639	2.015	-
Description: This effort was originally titled 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 2014 Accomplishments:** Continued to design and conduct experiments of a universal projectile concept to validate modeling and simulation of projectile aerodynamics, launch survivability and suitability to military environments; investigated gun barrel stabilization technologies to validate effectiveness of maximum range increases. **FY 2015 Plans:** Validate advanced armor piercing ammunition technology designs that achieve TRL 5 and prepare transition documentation for Project Manager Maneuver Ammunition Systems (PM MAS); mature weapon advanced stabilization concept for 6.3 transition.			
Title: Small Arms Material and Process Technology	3.953	2.518	-
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.			

PE 0602623A: *Joint Service Small Arms Program*
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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602623A *I Joint Service Small Arms Program*	**Project (Number/Name)** H21 *I Jt Svc Sa Prog (JSSAP)*	

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
FY 2014 Accomplishments: Developed and analyzed custom phosphors for providing day/night capable tracer material; validated phosphor characteristics (excitation and emission energies) to enhance focus light back to the shooter; matured coatings for corrosion resistant applications on ammunition and weapons; conducted experiments through suppressor development designs to decrease peak temperatures and increase reliability.			
FY 2015 Plans: Experiment with selected phosphors properties that provide one-way luminescence capability for 5.56mm and 7.62mm caliber ammunition; will investigate and evaluate suppressor designs to decrease flash and acoustic detection; validate adaptive solid lubricants to decrease required weapon maintenance and transition 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 Plans:* Investigate and evaluate advanced small arms kinetic ammunition designs; design 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; investigate futuristic small arms weapon systems proposed by the West Point Futures Studies and generate technology development plans, trade-off analysis, and concept designs.	-	2.317	-
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 non-lethal ranges than currently available. *FY 2016 Plans:* Will 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.	-	-	1.742
Title: Small Arms Ammunition Research	-	-	1.278

PE 0602623A: *Joint Service Small Arms Program*
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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602623A *I Joint Service Small Arms Program*	**Project (Number/Name)** H21 *I Jt Svc Sa Prog (JSSAP)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
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 soft and hard target performance. *FY 2016 Plans:* Will 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 the Army Research Laboratory (ARL).			
Title: Optics and Fire Control	-	-	1.841
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:* Will 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.			
Title: Small Arms Technology Applied Research	-	-	0.626
Description: This effort supports the requirements analysis and the long-term investigation and maturation of technologies to fulfill the Department of Defense small arms capabilities. 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:* 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 DOD small arms capabilities.			
Accomplishments/Planned Programs Subtotals	7.592	6.850	5.487

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602623A *I Joint Service Small Arms Program*	**Project (Number/Name)** H21 *I Jt Svc Sa Prog (JSSAP)*

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

Remarks

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army											Date: February 2015	

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

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
Total Program Element	-	52.013	63.057	48.340	-	48.340	57.038	49.245	57.509	61.313	-	-
H18: *Weapons & Munitions Technologies*	-	12.998	18.786	20.974	-	20.974	22.143	20.918	24.425	28.896	-	-
H19: *Asymmetric & Counter Measure Technologies*	-	8.795	6.985	13.212	-	13.212	15.324	9.482	12.865	11.602	-	-
H1A: *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE*	-	15.000	25.000	-	-	-	-	-	-	-	-	-
H28: *Warheads/ Energetics Technologies*	-	15.220	12.286	14.154	-	14.154	19.571	18.845	20.219	20.815	-	-

Note

FY16 increase to develop enabling component technologies that provide improved lethality with precision at extended ranges as well as sensor and warheads technologies that provide capabilities to move in constrained terrains.

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 US weapons as well as directed energy (DE) capabilities and subsystems to support the weaponization of High Power 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 Ground Maneuver and Lethality Portfolios 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, 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.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army				Date: February 2015	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*			**R-1 Program Element (Number/Name)** PE 0602624A I *Weapons and Munitions Technology*		

B. Program Change Summary ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Previous President's Budget	52.778	38.069	42.686	-	42.686
Current President's Budget	52.013	63.057	48.340	-	48.340
Total Adjustments	-0.765	24.988	5.654	-	5.654
• Congressional General Reductions	-	-0.012			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	25.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.765	-			
• Adjustments to Budget Years	-	-	5.654	-	5.654

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2014	FY 2015
Project: H1A: *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE*		
Congressional Add: *Program Increase*	15.000	25.000
Congressional Add Subtotals for Project: H1A	15.000	25.000
Congressional Add Totals for all Projects	15.000	25.000

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Appropriation/Budget Activity 2040 *I* 2				R-1 Program Element (Number/Name) PE 0602624A *I Weapons and Munitions Technology*					Project (Number/Name) H18 *I Weapons & Munitions Technologies*		

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
H18: *Weapons & Munitions Technologies*	-	12.998	18.786	20.974	-	20.974	22.143	20.918	24.425	28.896	-	-

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.

This project sustains Army science and technology efforts supporting the Ground and Lethality portfolios.

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 2014	FY 2015	FY 2016
Title: Novel Propulsion Technology for the Future	3.462	3.614	3.856

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 2014 Accomplishments:
Conducted experiments on rocket propulsion systems concepts to extend the range of 155mm artillery and 120mm mortar; determine ballistic applications for co-extruded propellants; leveraged advancements in combustible cartridge case technologies to improve projectile propulsion; designed and developed optimal propellant configurations for specific applicable systems; developed 120mm mortar propellant for 120mm systems for improved range and cost; developed and optimized advanced propellant for 81mm extended range system compliant with automated direct/indirect fire mortar (ADIM).

FY 2015 Plans:

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Appropriation/Budget Activity 2040 *I* 2	R-1 Program Element (Number/Name) PE 0602624A *I Weapons and Munitions Technology*	Project (Number/Name) H18 *I Weapons & Munitions Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Conduct initial experiments on non ammonium perchlorate propellant formulations for rocket assisted projectile indirect fire solutions; design and develop propellant technologies for next generation artillery and tank applications; scale up materials for advanced propellants, igniters and combustible materials for propellant charges. *FY 2016 Plans:* Will 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 resulting in more range over the temp spectrum and increased accuracy due to less propellant variation; formulate new materials for extended range artillery applications.			
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 2014 Accomplishments:* Matured most promising weapon technologies to enable swarming munitions that provide highly lethal target tailorable effects such as advanced miniature fuze and power systems and munition architectures for synergistic effects; evaluated for transition to advanced development; conducted additional small scale research into multiple novel weapon system candidate technologies, including fire control decision support services, and enhanced sniper technologies for improved precision at extended ranges. *FY 2015 Plans:* Investigate multiple promising innovative weapon technologies that could provide greater lethality; develop weapon technologies that incorporate emerging materials (e.g. nanotechnology, additive manufacturing); develop weapon, munition and fire control technologies that support advanced forms of engagement, such as collaborative munitions. *FY 2016 Plans:* Will continue to investigate innovative weapon technologies that could provide lethality improvements such as nanostructured materials for high strain rate applications and counter 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.	1.496	2.174	1.409
Title: Novel Penetrator Designs	1.662	-	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Description: This effort provides novel direct fire capabilities against advanced heavy armor threats by investigating several projectile configurations and non depleted uranium (DU) materials to achieve flight stability and effectiveness against new armored targets. *FY 2014 Accomplishments:* Optimized components for better function and launch survival; designed and modified non-DU kinetic energy (Next Generation KE) functional projectile leading to the tech demo.			
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 control technologies will be investigated for survivability and functionality through component level testing and modeling and simulation. The Warfighter will be able to use these technologies and handheld device to engage Beyond Line-of-Sight (BLOS) targets and guide the projectile in flight. *FY 2014 Accomplishments:* Matured component technologies such as aerodynamic shapes, tail fins, lift surfaces, improved propellant and base bleed for 60mm through 120mm mortar projectiles; conducted experiments for directing the projectile onto target at ranges beyond 500 meters; validated and matured electronic components for insertion into projectiles. *FY 2015 Plans:* Mature and validate 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; conduct an experimental flight of a guide to hit projectile at 75% increased range. *FY 2016 Plans:* Will 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.	0.979	0.991	0.988
Title: Affordable Precision Technologies *Description:* This effort investigates technologies that provide affordable precision capabilities for projectiles fired into GPS denied environments. *FY 2014 Accomplishments:*	2.453	3.282	2.675

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Conducted experiments to validate the concept of utilizing commercial-off-the-shelf (COTS) inertial sensors for guided munition applications; determined the feasibility of applying arrayed sensor concepts to gun launched munitions in order to determine position within navigation grade accuracies; validated target recognition algorithms adapted for use with the imaging modalities selected. *FY 2015 Plans:* Validate inertial sensor array design and processing algorithms developed: conduct various experiments with the long-wave/near-IR imagers used for terminal guidance in GPS denied environments. Nature of the experiments is to collect real time imagery data for the purpose of navigation algorithm development. This effort is being conducted in collaboration with AMRDEC through the ATR Working Group and with the Army Research Laboratory (ARL) through a technology transition agreement. This effort will spin 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:* Will 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 the Army Research Laboratory (ARL) through a technology transition agreement. .			
Title: Enabling Printed Explosives, Power Sources & Electronics for Munitions *Description:* This effort designs and evaluates the state-of-the-art in materials printing, direct write, flexible electronics, and conformal systems for the Warfighter. *FY 2014 Accomplishments:* Developed Printed Electronics, Energetics, Materials, & Sensors (PEEMS) technologies for armament applications; investigated ink development, device fabrication, and testing of printed electronics for current and future armament system; determine the utility of PEEMS technologies for munitions fuzing, sensing, security, and logistics. *FY 2015 Plans:* Investigate, design, develop and validate printed electronics, energetics, and power sources for Munitions and other armament applications; mature 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	0.692	0.694	0.747

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Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602624A *I Weapons and Munitions Technology*	**Project (Number/Name)** H18 *I Weapons & Munitions Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
effort is being conducted in collaboration with CERDEC, AMRDEC and the Army Research Laboratory (ARL) through both the integrated project team and technical working groups. *FY 2016 Plans:* Will investigate, design and adopt 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: Air Dropped Guided Munition Technology *Description:* This effort develops and integrates component technologies that enable the precision delivery and function of an 81mm mortar to defeat moving targets of opportunity in complex terrain. *FY 2014 Accomplishments:* Matured designs and analyze integration of Proximity Fuze system, with a wrap around antenna, and semi active laser seeker components, designed and developed to fit the volume and form factor of low cost and light weight air drop 60-81mm munitions.	1.272	-	-
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 2014 Accomplishments:* Identified candidate technologies that can be used to facilitate hyper-velocity launch; investigate viability of candidate technologies; developed concepts utilizing the most promising technologies; identified the subcomponent technological gaps that need to be addressed early. *FY 2015 Plans:* Mature the concepts of an extended range armament system; continue the investigation of unconventional materials and processes to allow a new system to have no significant weight increase compared to existing systems; develop a detailed design of a lightweight armament system for use in extended range weapons that addresses the current Army capability gaps with minimal system impact. *FY 2016 Plans:*	0.982	1.021	2.287

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Will 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.			
Title: Force Protection Technologies	-	3.010	3.512
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 Plans:** Investigate and develop armament technologies to provide protection to vital National assets including vehicles, facilities, weapons, and personnel; develop precision weapons, munitions and fire control technologies to reduce collateral damage to non-combatants; develop armament technologies that provide greater standoff distance between incoming threats and vital assets. **FY 2016 Plans:** Will continue to investigate and develop 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			
Title: Long Range Gun Technology Development	-	2.000	3.500
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. **FY 2015 Plans:** Investigate candidate projectile and weapon systems technologies that provide extended range by leveraging novel materials, innovative propulsion technologies and advanced design concepts. **FY 2016 Plans:** This effort is being conducted in concert with the Extended Range Indirect Fire Weapon Technology effort. Resulting component technologies will be evaluated and matured in the fully coordinated effort of the same name in PE/Project 0603004A/232. These new technologies will apply to light weight common armament , advanced micro-common fire control, novel post launch propulsion methods, and advanced projectile lifting surfaces.			
Title: Fuze and Power Technologies for Munitions	-	2.000	2.000

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Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602624A *I Weapons and Munitions Technology*	**Project (Number/Name)** H18 *I Weapons & Munitions Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Description: This effort investigates and design 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 Plans:* 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:* Will 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)			
Accomplishments/Planned Programs Subtotals	12.998	18.786	20.974

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 *I* 2				**R-1 Program Element (Number/Name)** PE 0602624A *I Weapons and Munitions Technology*					**Project (Number/Name)** H19 *I Asymmetric & Counter Measure Technologies*		

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
H19: *Asymmetric & Counter Measure Technologies*	-	8.795	6.985	13.212	-	13.212	15.324	9.482	12.865	11.602	-	-

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. Work in this project is related to, and fully coordinated with, efforts in projects H18 and H28 (also in PE 0602624A), PE 0602618A (Ballistics Technology), and projects 232 and L94 in PE 0603004A (Weapons and Munitions Advanced Technology).

The cited work is consistent with the Director, Defense Research and Engineering Strategic Plan, the Army Modernization Strategy, and the Army Science and Technology Master Plan.

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 2014	FY 2015	FY 2016
Title: Novel Battlefield Effectors *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 2014 Accomplishments:* Investigated additional new and promising effector technologies and evaluated them for transition to advanced development; conducted experiments to enable size, weight, power and cost (SWaP-C) reduction of solid state active denial technologies to allow for handheld applications and for use on the design of other novel battlefield effector candidate technologies. *FY 2015 Plans:* Develop most promising effector technologies for transition to advanced development; investigate size, weight, power and cost benefits of those technologies; explore the use of non-traditional technologies in new applications. *FY 2016 Plans:* Will 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.	0.684	1.600	1.753
Title: Counter Countermeasure (CCM) Technologies for weapons and munitions	0.881	1.369	1.445

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Appropriation/Budget Activity 2040 I 2	**R-1 Program Element (Number/Name)** PE 0602624A I *Weapons and Munitions Technology*	**Project (Number/Name)** H19 I *Asymmetric & Counter Measure Technologies*	

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
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 2014 Accomplishments:* Designed CCM systems to protect against known vulnerabilities and evaluate for transition to advanced development; investigated multiple counter countermeasure candidate technologies; explored susceptibilities and remediation techniques for armament systems; conducted various experiments to measure effects of directed energy and developed modeling and simulation to understanding underlying physics. *FY 2015 Plans:* Develop most promising technologies that protect munitions and weapons technologies against emerging threat countermeasure technologies; explore disruptive directed energy as a means of providing CCM; investigate most promising CCM technologies for transition to advanced development. *FY 2016 Plans:* Will conduct experimentation of Counter Counter Measure technologies for gun launched munition components in a relevant laboratory environment.			
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 2014 Accomplishments:* Utilized systems engineering to investigate the state-of-the-art of optics, microprocessors and target recognition/classification algorithms based on market surveys of private industry/academia/other government agencies' sensor technologies; established, developed and matured the associated fire control system requirements and performance goals; generated and evaluated concepts for software and hardware architectures for optimal fire control system performance and size, weight and power considerations. *FY 2015 Plans:*	2.780	2.011	2.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Develop novel methods and algorithms for improved ballistics, for data and image processing, and for sensing battlefield, weapon and target environment; investigate small, accurate, survivable weapon orientation sensors, technologies and compensation methodologies to improve the weapon pointing; refine concepts for hardware and software architectures for optimum physical and functional integration, increased commonality, lower weight, and faster engagement times. *FY 2016 Plans:* Will 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 size, weight, power and cost (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.			
Title: Improvised Explosive Device (IED) Neutralization Technologies *Description:* This effort investigates multiple radio frequency (RF) functions to neutralize IEDs utilizing a common set of hardware and software, on a ground vehicle. It develops novel RF waveforms to neutralize a broad spectrum of IEDs and their electronic triggering devices. Results to transition to explosive hazard predonation system effort in PE 0603004A/Project 232 in FY2014/15. *FY 2014 Accomplishments:* Matured existing IED neutralization systems; conducted research to include the development of IED neutralization waveforms utilizing a modular exciter architecture, and developed a beam steering directional antenna to focus high power RF towards predicted threat zones to neutralize the IED; validated the increased performance of a convoy / route clearance based IED neutralization system by interfacing with IED detection sensor systems.	1.958	-	-
Title: Integrated Decision Enhancing Capabilities for Fire Control *Description:* This effort develops target database and target management capability for company and below operations. *FY 2014 Accomplishments:* Developed software for integration and collaboration of remote weapon station for lethal/non lethal effects; developed software for the processing and integration of sensor/target information; developed Line-Of-Sight/Beyond-Line-Of-Sight (LOS/BLOS) fires capability for company and below within program of record architecture.	0.490	-	-
Title: High Powered Radio Frequency	-	2.005	2.007

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
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 Size, Weight, Power and Cost (SWAP - C) of High Power RF systems and their components so as to allow tactically useful systems. *FY 2015 Plans:* Focus on reducing antenna size for high power RF transmission; investigate high dielectric constant composites (nano-dielectics) to produce 60-80% size reduction in antenna array elements; develop 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:* Will 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.			
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:* Will 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.	-	-	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 the time of engagement, and enhance the situational awareness. By achieving these objectives, the soldier will be able to improve his opertional effectiveness in reduced time. *FY 2016 Plans:* Will 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	-	-	4.007

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015	
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602624A *I Weapons and Munitions Technology*	**Project (Number/Name)** H19 *I Asymmetric & Counter Measure Technologies*	

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
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.			
Title: Recoil Reduction Disruptive Technologies *Description:* This effort investigates technologies to reduce recoil momentum and energy waste for integration onto lighter vehicle platforms for increased mobility, using rarefaction wave gun and supporting technologies. *FY 2014 Accomplishments:* Investigated fundamental means of radical recoil reduction to enable large caliber weapons to be lightweight and integrated to lightweight manned and unmanned vehicles; funded research into rarefaction wave gun and supporting technologies for use in supersonic up to hypervelocity launchers.	2.002	-	-
Accomplishments/Planned Programs Subtotals	8.795	6.985	13.212

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army											**Date:** February 2015	
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602624A *I Weapons and Munitions Technology*					**Project (Number/Name)** H1A *I WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE*			
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
H1A: *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE*	-	15.000	25.000	-	-	-	-	-	-	-	-	-

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 2014**	**FY 2015**
Congressional Add: Program Increase	15.000	25.000
FY 2014 Accomplishments: Investigated, designed and evaluated enabling technology to develop lethal and nonlethal weapons and munitions with increased performance and the potential for lower weight, reduced size, and improved affordability.		
FY 2015 Plans: Program increase for weapons and munitions technology research.		
Congressional Adds Subtotals	15.000	25.000

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army							**Date:** February 2015				
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602624A *I Weapons and Munitions Technology*				**Project (Number/Name)** H28 *I Warheads/ Energetics Technologies*			

COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
H28: *Warheads/ Energetics Technologies*	-	15.220	12.286	14.154	-	14.154	19.571	18.845	20.219	20.815	-	-

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.

This project sustains Army science and technology efforts supporting the Ground and Lethality portfolios.

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 U.S. 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 2014**	**FY 2015**	**FY 2016**
Title: Scalable Warhead Technology ***Description:*** This effort designs scalable and adaptive explosives and reactive materials technology for either gun or missile-launched weapons and munitions that can deliver a broad spectrum of effects with reduced collateral damage. ***FY 2014 Accomplishments:*** Designed and conducted experiments for spin compensated shaped charges, enhanced fragmentation and multiple explosively formed penetrator (MEFP) warheads; investigated scalable technologies as they relate to lethal to less than lethal effects; develop designs for non-axisymmetric EFP warheads. ***FY 2015 Plans:*** Mature designs and conduct 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:*** Will design and develop multi-functional warheads for multi-role missions that include C-RAM, C-UAS and anti-vehicle/personnel. Will design and test brass board designs for shaped charge, explosively formed penetrator (EFP) and blast fragmentation with	4.085	4.392	6.193

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015
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 2014	FY 2015	FY 2016
targeted lethality; will determine through modeling and simulation of tunable/tailorable effects for adaptable warheads for future artillery, mortars and medium caliber munitions.			
Title: Energetic Materials and Warheads *Description:* This effort designs energetic materials with controlled energy release for precision munition and counter-munition applications. *FY 2014 Accomplishments:* Continued to investigate most promising technologies such as disruptive energetics, micro-thrusters and tailorable propellants, highly effective miniature lethal mechanisms, and nano insensitive nitramines; also conducted evaluation for transition into novel swarming munitions, advanced warheads, medium and large cal ammunition; seek new applications based on measured performance.	1.803	-	-
Title: Explosives Research *Description:* This effort develops high energy/high performance, multi-purpose insensitive munitions (IM) explosives. *FY 2014 Accomplishments:* Determined most promising compounds to enable tailored energy release and combined effects; investigated and characterized new insensitive energetic ingredients; designed and developed novel concepts for explosive initiation and formulation; scale up and test Nano energetic materials in TRL-4-5 experiments; developed nano-enhanced melt pour ingredients for reduced sensitivity and cost. *FY 2015 Plans:* Formulate and process combined effects and high efficiency explosives; validate affordable new energetic binders for enhanced blast formulations; investigate new synthetic processes to enable low-cost, high energy solid crystal explosive ingredients; mature processing techniques for nano-enhanced organic energetics formulations; conduct 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 is being conducted in collaboration with the Army Research Laboratory (ARL) through both the integrated project team and technical working groups. *FY 2016 Plans:* Will continue to investigate single step nano-enhaced explosive munitions with greatly reduced shock sensitivies. Will validate lethality and fragmentation concepts. Will investigate scale up high pressure synthesis chemistry of disruptive energetic materials.	4.937	4.064	4.861

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602624A *I Weapons and Munitions Technology*	**Project (Number/Name)** H28 *I Warheads/ Energetics Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Will validate high efficiency explosive concepts in munition systems. This effort is being conducted in collaboration with the Army Research Laboratory (ARL) through both the integrated project team and technical working groups.			
Title: Material Development for Water Purification	0.489	0.248	-
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. Lesser focus advantages are on sustainment, greater logistics flexibility, and reduced Warfighter threat from supply convoys. *FY 2014 Accomplishments:* Investigated cycle time and water flow, determined rate of reaction for decontamination, validated the coating to lend itself useful for robustness of current filters, and designed and developed laboratory systems for conducting experiments. *FY 2015 Plans:* Design and develop a method to collect real time data to determine flow rates and validate water purity; conduct 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	0.300	0.497	-
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. In FY 2014 this effort supports the Demonstration of Force Protection for Basing. *FY 2014 Accomplishments:* Determined data interoperability requirements of explosives safety, risk assessment, and base camp planning tools leading to the development of the design architecture for an automated comprehensive base camp planning software suite. *FY 2015 Plans:* Develop and evaluate 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.			
Title: Tunable Pyrotechnics	3.606	3.085	3.100
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. This will increase warfighter and aircraft survivability. *FY 2014 Accomplishments:*			

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602624A *I Weapons and Munitions Technology*	**Project (Number/Name)** H28 *I Warheads/ Energetics Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Investigated ultraviolet countermeasure (UVCM) flare reformulation with modeling & simulation and validated in scale up experiments; developed and validated laser beam rider countermeasure (LBRCM) designs with functional experiments; designed & developed image seeking countermeasure (ISCM) flare configurations; matured and validated white illumination hand held signal designs. *FY 2015 Plans:* Assess formulations and functional concepts for dazzler, cloud and seeker countermeasures; conduct experiments on dazzler flares and prepare for flight tests; conduct experiments on cloud countermeasures; analyze dazzler and cloud countermeasure performance using experiment and simulation results for application to multiple aircraft and aspect angles; identify threats and develop concepts for seeker countermeasure. *FY 2016 Plans:* Dazzler Countermeasure formulations will be refined along with additional flight testing. Dazzler M&S algorithms will be refined as well. Cloud Countermeasure will undergo final prototype formulation full up system level demonstrations on aircraft. M&S algorithms will be updated for Cloud Countermeasure. Advanced Countermeasure will have initial formulations and flare concepts tested against hardware in the loop threat seekers. Digital M&S algorithms will be developed.			
Accomplishments/Planned Programs Subtotals	15.220	12.286	14.154

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army											Date: February 2015	

| Appropriation/Budget Activity
2040: Research, Development, Test & Evaluation, Army I BA 2: Applied Research | | | | | | R-1 Program Element (Number/Name)
PE 0602705A I Electronics and Electronic Devices | | | | | | |

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
Total Program Element	-	68.062	73.422	55.301	-	55.301	57.002	55.296	55.922	57.021	-	-
EM4: Electric Component Technologies (CA)	-	10.000	17.000	-	-	-	-	-	-	-	-	-
EM8: High Power And Energy Component Technology	-	14.532	13.177	12.143	-	12.143	12.680	12.888	12.937	13.194	-	-
H11: Tactical And Component Power Technology	-	11.475	11.766	11.810	-	11.810	11.914	9.641	9.602	9.791	-	-
H17: Flexible Display Center	-	2.617	0.571	1.136	-	1.136	1.011	1.024	1.074	1.096	-	-
H94: Elec & Electronic Dev	-	29.438	30.908	30.212	-	30.212	31.397	31.743	32.309	32.940	-	-

Note

 FY14 reprogramming moved Congressional add for Silicon Carbide research from 0602105A for proper execution.

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, fabricates and evaluates advanced portable power technologies (batteries, fuel cells, hybrids, generators, chargers, and 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.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602705A *I Electronics and Electronic Devices*	

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

B. Program Change Summary ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**
Previous President's Budget	58.990	56.435	55.672	-	55.672
Current President's Budget	68.062	73.422	55.301	-	55.301
Total Adjustments	9.072	16.987	-0.371	-	-0.371
• Congressional General Reductions	-	-0.013			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	17.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	10.000	-			
• SBIR/STTR Transfer	-0.928	-			
• Adjustments to Budget Years	-	-	-0.371	-	-0.371

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2014**	**FY 2015**
Project: EM4: *Electric Component Technologies (CA)*		
Congressional Add: *Silicon Carbide Research*	10.000	12.000
Congressional Add: *Program increase*	-	5.000
Congressional Add Subtotals for Project: EM4	10.000	17.000
Congressional Add Totals for all Projects	10.000	17.000

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army											**Date:** February 2015	
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602705A *I Electronics and Electronic Devices*					**Project (Number/Name)** EM4 *I Electric Component Technologies (CA)*			
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
EM4: *Electric Component Technologies (CA)*	-	10.000	17.000	-	-	-	-	-	-	-	-	-

Note
Not applicable for this item.

A. Mission Description and Budget Item Justification
Congressional Interest Item funding for Electronic Component applied research.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**
Congressional Add: Silicon Carbide Research	10.000	12.000
FY 2014 Accomplishments: Researched high-voltage high-power density SiC power devices and power components.		
FY 2015 Plans: Continue research on SiC power devices and power components.		
Congressional Add: Program increase	-	5.000
FY 2015 Plans: This is a Congressional interest item.		
Congressional Adds Subtotals	10.000	17.000

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

D. Acquisition Strategy
N/A

E. Performance Metrics
N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army										Date: February 2015	
Appropriation/Budget Activity 2040 I 2				**R-1 Program Element (Number/Name)** PE 0602705A I *Electronics and Electronic Devices*					**Project (Number/Name)** EM8 I *High Power And Energy Component Technology*		

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
EM8: *High Power And Energy Component Technology*	-	14.532	13.177	12.143	-	12.143	12.680	12.888	12.937	13.194	-	-

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); and traditional and non-traditional RF and laser electronic attack. 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 (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 U.S. Army Tank and Automotive Research, Development, and Engineering Center (TARDEC); Armaments Research, Development, and Engineering Center (ARDEC); the U.S. Army Aviation and Missile Research, Development, and Engineering Center (AMRDEC); and the U.S. 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 U.S. Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: High Power and Energy Technologies	1.098	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 2014 Accomplishments:*			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 I 2	**R-1 Program Element (Number/Name)** PE 0602705A I *Electronics and Electronic Devices*	**Project (Number/Name)** EM8 I *High Power And Energy Component Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Investigated and developed wide band gap materials and devices, for operation above 20kV to support survivability, lethality systems, and high voltage micro-grid application requirements; evaluated high voltage packaging needs and identified packaging research; and initiated research into wide band-gap semiconductors identified in FY13. *FY 2015 Plans:* Investigate and develop advanced wide band gap materials and devices, for operation above 20kV to support survivability, lethality systems, and high voltage microgrid application requirements; research and evaluate high voltage packaging needs; and continue research into wide band-gap semiconductors identified in FY14. *FY 2016 Plans:* Will validate a 20kV 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 40kV for use in advanced Directed Energy systems and other Lethality and Survivability applications.			
Title: High Energy Laser Technology *Description:* Research novel solid-state laser concepts, architectures, and components with the goal of providing technology to Army directed energy weapon developers. Exploit breakthroughs in laser technology, material development and photonics basic research to meet the stringent weight/volume requirements for platforms. Applied research will be conducted in close collaboration with domestic and foreign material vendors, university researchers, and major laser diode manufacturers. *FY 2014 Accomplishments:* Experimentally validated feasibility of a fiber laser which could provide significantly improved thermal management in order to achieve advanced power scalability (>10X) with good beam quality; and scaled chirped diode laser seed technique to obtain multi-kW power output from a 1060 nm fiber amplifier. *FY 2015 Plans:* Investigate techniques for power scaling continuous wave (CW) and pulsed mid-wave infrared (IR) sources for IR countermeasure (IRCM) applications; and explore laser materials with enhanced thermal conductivity that will provide superior ability to meet stringent Army size, weight, and power (SWAP) requirements for counter rocket, artillery, and mortar (C-RAM) applications. *FY 2016 Plans:* Will explore novel fiber designs to increase power while preserving high beam quality for enabling laser directed energy weapons; 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 LADAR application.	2.477	2.000	2.000
Title: Directed Energy (DE) /Electromagnetic Environments (EME) Technologies	2.322	2.386	2.325

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 I 2	**R-1 Program Element (Number/Name)** PE 0602705A I *Electronics and Electronic Devices*	**Project (Number/Name)** EM8 I *High Power And Energy Component Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Description: Investigate and evaluate emerging technologies related to DE technology, electronic warfare (EW) survivability/ lethality, operations in the EME, and supporting high power components with the goal of enhancing the survivability/lethality of Army platforms. *FY 2014 Accomplishments:* Characterized the susceptibility of emerging Improvised Explosive Device (IED) threats to identify their unique susceptibilities/ vulnerabilities; designed neutralization waveforms and techniques based on their vulnerabilities; and developed and evaluated smart radio frequency (RF) waveforms to create countermeasures to affect electronic devices. *FY 2015 Plans:* Determine the susceptibility of emerging threat electronics (to include those related to IEDs) to electronic attack; characterize parameters for use in the development of neutralization waveforms and techniques; investigate Digital Radio Frequency Memory (DRFM) technology and its effects on jamming/counter-jamming applications; and develop cognitive RF architecture and baseline hardware and algorithms for sensing and exploiting electromagnetic environment. *FY 2016 Plans:* Will develop electronic protection (EP) device technologies for Next Generation Radar requirements by examining the adaptive RF technology threat against Army radar performance.			
Title: Electronic Components and Materials Research *Description:* Investigate, and evaluate compact, high-efficiency, high-temperature, 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 2014 Accomplishments:* Investigated advanced control and diagnostic methods intended for power switches to improve fault tolerance and efficiency; conducted applied research on next-generation materials and fabrication methods for passives and wide band-gap materials and devices and developed switching components to provide power conversion components for micro-grid applications. *FY 2015 Plans:* Investigate both gallium nitride (GaN) and silicon carbide (SiC) based electronic components for device reliability and characterize these materials; investigate advanced control and diagnostic methods for power switches to improve fault tolerance and efficiency; conduct applied research on next-generation materials and fabrication methods for compact power switching components that	4.195	3.000	3.234

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015	
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602705A *I Electronics and Electronic Devices*	**Project (Number/Name)** EM8 *I High Power And Energy Component Technology*	

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
provide high voltage, high current, and/or high frequency operation; and investigate and develop advanced power semiconductor devices and modules, for operation above 20kV and at high currents. *FY 2016 Plans:* Will evaluate and develop reliability models of current and next generation wide band-gap electronic components for device enhancements; demonstrate 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.			
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, vehicle, and micro-grid (installation) applications to include the operation of military-specific power distribution topologies at the system and circuit levels. *FY 2014 Accomplishments:* Conducted applied research in 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; researched intelligent control methodologies for micro-grids and other power distribution systems; and investigated bidirectional power conversion circuits for platform and micro-grids. *FY 2015 Plans:* Conduct 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; investigate advanced behavior based Tactical Energy Network control and prediction techniques; and research distributed control strategies to enable more robust and failure resistant grids (e.g. utilize 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; continue to investigate controls for Tactical Energy Network control and prediction techniques allowing any power input to feed any output power specification; develop distributed control and storage models to demonstrate more reliable and failure tolerant grids; and continue to investigate through modeling and analysis the use of direct current and hybrid grid based technologies for the Army Tactical Energy Network.	3.720	4.609	3.351
Title: Pulsed-Power Components and Systems Research *Description:* Investigate, and evaluate emerging technologies such as energy storage capacitors, high voltage converters, high rate-of-current-rise semiconductor switches, and explosive-based pulse generators that improve the reliability and efficiency of	0.720	-	-

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Appropriation/Budget Activity 2040 I 2	**R-1 Program Element (Number/Name)** PE 0602705A I *Electronics and Electronic Devices*	**Project (Number/Name)** EM8 I *High Power And Energy Component Technology*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
pulsed-power components for applications such as electromagnetic armor, electronic fuze initiators, and electronic protection systems. *FY 2014 Accomplishments:* Analyzed semiconductor switch and component operation under extreme currents and voltages; experimentally characterized and validated improved FY13 SiC switches and other components for electromagnetic armor systems; and developed enhanced power dense power conversion hardware to reduce size and weight for platform survivability efforts through the implementation of novel materials, circuits and module designs.			
Accomplishments/Planned Programs Subtotals	14.532	13.177	12.143

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army										Date: February 2015	
Appropriation/Budget Activity 2040 I 2				**R-1 Program Element (Number/Name)** PE 0602705A I *Electronics and Electronic Devices*						**Project (Number/Name)** H11 I *Tactical And Component Power Technology*	

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
H11: *Tactical And Component Power Technology*	-	11.475	11.766	11.810	-	11.810	11.914	9.641	9.602	9.791	-	-

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 small unit & Soldier power management, decision making, and distribution. This project also researches power sources that are smaller and more fuel-efficient, advanced cooling systems that enable tactical sustainability and survivability.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Tactical Power Generation Technology (formerly Soldier Power Technologies) **Description:** This effort designs, fabricates and validates Soldier-borne hybrid power sources, batteries, rapid battery chargers, and power management software, devices and techniques in order to decrease Soldier load and power burden, increase power capabilities such as extending battery run-time, decrease battery sizes/costs and increase power management and situational awareness. **FY 2014 Accomplishments:** Investigated very high energy density lighter weight Soldier hybrid power sources including wearable conformal Li/Air disposable batteries; increased power density of Li/Air by designing, fabricating and assessing carbon nano-based air electrodes; investigated highly conducting, robust, lower cost lithium ion conducting membranes to further reduce weight and cost of Soldier batteries; investigated renewable multi-fueled Soldier portable power sources and aluminum hydride (high energy density) based fuel cells with extended run time, higher energy density and higher fuel to energy conversion efficiency; assessed Soldier wireless power and energy harvesting concepts to reduce electrical wiring and connectors, achieve greater power transmission efficiencies	7.579	7.526	4.673

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army			Date: February 2015		
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 2014	FY 2015	FY 2016
and reduce energy logistics for extended missions; investigated processes, techniques and hardware for safe wireless power distribution for Soldier borne equipment and wireless charging of Soldier borne batteries. *FY 2015 Plans:* Mature very high energy density hybrid power sources as a wearable conformal power source; design 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; mature internal components to facilitate a renewable multi-fueled Soldier portable power source; investigate a system to integrate wireless power and energy harvesting technologies into the smart Soldier power grid to reduce cabling and connectors; continue to investigate techniques to increase wireless power transfer efficiency and distance; conduct experiments on novel energy harvesting components to increase efficiency and reduce weight of carried power sources. *FY 2016 Plans:* Will 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.			
Title: Energy Informed Operations **Description:** This effort investigates power generation materials, components and systems to increase energy output, reduced weight and noise, while increasing fuel and cost efficiency in mobile power generation sources. Products are silent mobile power components and materials, waste-heat recovery components and systems, transitional power sources in the 500 watts (W) to 2 kilowatts (kW) range, towable generator sets up to 100 kW and renewable energy components and power management systems up to 5 kW. *FY 2014 Accomplishments:* Investigated monitoring tools for Squad, Platoon and Brigade command post renewable energy power grids (300 W to 10 kW) to provide grid status to the commander; coded intelligent power management protocols to increase reliability and efficiency of renewable energy integrated with fossil fuel generators; designed and assessed high energy density, efficient energy storage modules; investigated advanced harvesting of carbon dioxide (CO_2) from exhaust to provide for autonomous power generation (fuel cells and external/internal combustion) and reduced fuel logistics; designed alternative CO_2 based co-generation capabilities for greater cooling capacity and reduced weight/size of environmental control units. *FY 2015 Plans:*	3.896	4.240	7.137

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602705A *I Electronics and Electronic Devices*	**Project (Number/Name)** H11 *I Tactical And Component Power Technology*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Develop 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; design 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; establish standards for renewable power generation and energy storage and incorporate into demonstration grid; establish power management protocols and policies for interfacing with mission systems; develop power planning tools and applications for monitoring and controlling grid status; develop advanced 2kW fuel efficient silent power generation systems with greater than 30% fuel to electric efficiencies. *FY 2016 Plans:* Will 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.			
Accomplishments/Planned Programs Subtotals	11.475	11.766	11.810

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army										Date: February 2015	
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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
H17: *Flexible Display Center*	-	2.617	0.571	1.136	-	1.136	1.011	1.024	1.074	1.096	-	-

A. Mission Description and Budget Item Justification

This project fabricates and evaluates flexible display and electronic components emerging from the Army's Flexible Display Center (FDC) at the Arizona State University and materials and devices for flexible electronics developed at the Army Research Laboratory. This applied research on flexible display and electronic technologies makes them inherently rugged (no glass), light weight, conformal, potentially low cost, and low power. The resultant technology would enable enhanced and new capabilities across a broad spectrum of Army applications (such as hands-free/wrist mounted situational awareness devices, flexible X-Ray devices, large areas sensor, tagging, tracking, and soldier monitoring.)

This project supports Army science and technology efforts in the Command, Control, Communications and Intelligence 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 executed by the U.S. Army Research Laboratory (ARL), Adelphi, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Flexible Display Center (FDC) and Flexible Electronics Development	2.617	0.571	1.136
Description: The Flexible Display Center is developing high resolution flexible reflective (electrophoretic) and emissive (organic light emitting diodes) displays and sensing arrays. The U.S. Army Research Laboratory is developing materials and devices and processes for flexible electronics for Army applications. **FY 2014 Accomplishments:** Developed flexible electronic sensor devices for Army applications to include radiation sensors (visible to x-ray) and particle detection. **FY 2015 Plans:** Develop 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:**			

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army			**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602705A *I Electronics and Electronic Devices*	**Project (Number/Name)** H17 *I Flexible Display Center*	

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Will develop flexible hybrid electronic systems integrating traditional silicon electronics, sensors and power. The applications will include flexible sensing systems for human assessment with situational awareness on 2-dimensional flexible substrates and integrated into 3-dimensional structures for Soldier and small platform applications.			
Accomplishments/Planned Programs Subtotals	2.617	0.571	1.136

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army										Date: February 2015	

Appropriation/Budget Activity 2040 *I* 2	R-1 Program Element (Number/Name) PE 0602705A *I Electronics and Electronic Devices*	Project (Number/Name) H94 *I Elec & Electronic Dev*

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
H94: *Elec & Electronic Dev*	-	29.438	30.908	30.212	-	30.212	31.397	31.743	32.309	32.940	-	-

Note
Not applicable for this item.

A. Mission Description and Budget Item Justification

This project designs and evaluates electronics and electronic components and 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 imaging (IR), photonics, and prognostics and diagnostics. Areas of research relevant to power and energy include power and thermal management, micro-power generators and advanced batteries, fuel reformers, fuel cells for hybrid power sources, and photosynthetic routes to fuel and electricity.

This project supports Army science and technology efforts in the Command Control and Communications, Soldier, Ground and Air portfolios. Work in this project is fully coordinated with PE 0602709A (Night Vision Technology), PE 0603001A (Warfighter Advanced Technology), PE 0603004A (Weapons and Munitions Advanced Technology), PE 0603005A (Combat Vehicle and Automotive Advanced Technology), PE 0603008A (Command, Control, Communications Advanced Technology), PE 0603313A (Missile and Rocket Advanced Technology) and PE 0603772A (Advanced Tactical Computer Science and Sensor Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Antennas and Millimeter Wave Imaging *Description:* This effort designs evaluates 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 2014 Accomplishments:* Developed new terahertz detector for covert surveillance; continue millimeter wave antenna development; developed and evaluated carbon nanotube based antenna structures for potential integration into soldier uniforms; and designed and developed	4.574	3.439	3.490

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015
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 2014	FY 2015	FY 2016
antenna components to allow interoperability of and reduce interference between electronic warfare and communications functions on a single antenna system; and validated performance of antenna components in laboratory experiments. *FY 2015 Plans:* Evaluate the performance of millimeter wave transceivers for covert communications and sensing; extend and modify microwave radar rain scattering models to frequencies above 200 GHz to support transmission of data through rain and dust; and develop and evaluate conformal antennas for non-standard vehicle, covert applications. *FY 2016 Plans:* Will devise and evaluate carbon nanotube antennas woven into the fabric of the soldier's uniform; perform in-situ simulation of printed and paint-on antenna designs and low-profile metaferrite antenna designs.			
Title: Advanced Micro and Nano Devices *Description:* This effort designs and evaluates micro and nanotechnology components for multifunctional and integrated radio frequency (RF) applications, microrobotics, integrated energetics, control sensor interfaces and sensors for improved battlefield awareness. Work being accomplished under PE 0601102A /project H47 complements this effort. *FY 2014 Accomplishments:* Developed, synthesized and evaluated conformal and transparent graphene based electronics, and super-capacitors for high energy and power density; developed MEMS ultra high frequency (UHF) switchable filter module with variable bandwidth, center frequency tuning, and insertion loss <3 dB; investigated integration of MEMS and nano-energetics to enable directionality for jumping microrobots; developed piezoMEMS actuators for tethered flight and millimeter scale robotics; developed a digital interface between the MEMS acceleration switch arrays and the electronics to reduce power consumption; and investigated MEMS-based magnetic permeability sensing hardware for reading and writing non-erasable magnetic memory. *FY 2015 Plans:* Develop and prototype 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; continue investigation of novel stacked two dimensional (2-D) 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; develop nanoscale energetic materials for micro-autonomous vehicle propulsion, technology protection, and fuze initiators; optimize magnetic tunnel junction interface with magnetic permeability bits to enhance memory density and read speed; develop MEMS acoustic vector intensity probes for target localization and wind mitigation; and develop intrusion detection algorithm to enhance communication link security. *FY 2016 Plans:*	2.348	2.318	2.127

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
Appropriation/Budget Activity 2040 I 2	R-1 Program Element (Number/Name) PE 0602705A I *Electronics and Electronic Devices*	Project (Number/Name) H94 I *Elec & Electronic Dev*	

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Will develop and verify 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; demonstrate digital circuits on flexible stacked 2-D electronic materials (e.g. graphene, molybdenum disulphide, boron nitride); and explore and optimize the RF performance of stacked 2-D electronic materials.			
Title: Millimeter Wave Components and Architectures for Advanced Electronic Systems *Description:* This effort researches, designs and evaluates component materials, structures, devices, and the electromagnetic issues of millimeter wave (mmw) components and active devices. The goal is to develop components that can enable advanced systems that combine multiple RF functionalities. *FY 2014 Accomplishments:* Investigated and evaluated RF component integration techniques; built and evaluated test antennas and amplifiers capable of receiving inherently weak wideband threat signatures; and designed and fabricated a circuit that digitizes signals at mmw frequencies to enable architectures for SATCOM with smaller form factors. *FY 2015 Plans:* Develop and test multi-function RF components capable of receiving weak signals and threat detection using a combination of advanced processing and hardware architectures; investigate novel thermal management techniques for heat removal in high power amplifiers; and develop and evaluate efficient, wideband, secured communications at mmw/terahertz frequencies. *FY 2016 Plans:* Will 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 in order to enable multiple-function hardware as frequency-RF performance requirements converge.	5.570	5.581	5.267
Title: Imaging Laser Radar (Ladar) and Vision Protection *Description:* This effort develops and assesses eye-safe three dimensional (3-D) laser radar (ladar) components and phenomenology for long-range reconnaissance and short-range unmanned ground and air vehicle applications. The effort also develops and evaluates materials for passive protection of electro-optic (EO) vision systems from lasers. *FY 2014 Accomplishments:* Integrated and evaluated enhanced switching technology with an inorganic crystal-based optical switch for improving laser protection electro-optic shutters; developed and evaluated skin-based spectroscopic and advanced holographic technologies	2.715	2.722	2.659

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
for the identification and verification of uncooperative subjects; and designed and developed miniaturized components for high resolution active imaging systems (ladar and holographic) for higher range and angular resolution. ***FY 2015 Plans:*** Advance the development of fast EO shutters using inorganic crystal-based materials in conjunction with device tiling with the goal of increasing aperture size for non-focal plane vision protection from lasers; research new ladar concepts to reduce hardware cost/complexity and multi-spectral illumination to detect explosive constituents and targets; and conduct field experimentation on novel hostile fire sensing component technology. ***FY 2016 Plans:*** Will study 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 unattended air vehicle (UAV) navigation; study novel and advanced optical science concepts, such as computational imaging and holography for enhanced imaging and sensing applications.			
Title: Photonics and Opto-Electronic devices ***Description:*** This effort investigates and evaluates novel photonic components and architectures to enable detection of hazardous substances for enhanced Soldier situational awareness and survivability. In addition, this effort develops and assesses the hybridization of opto-electronic (OE) devices with electronics for optical fuze applications. ***FY 2014 Accomplishments:*** Measured the optical spectra of energetic and energetic related materials using ultra fast laser spectroscopy techniques and infrared photo-acoustic spectroscopy to identify explosive materials; and simulate, fabricate, and characterize advanced silicon photonic devices for improved sensing and processing. ***FY 2015 Plans:*** Evaluate ultrafast laser spectroscopy techniques, especially multiplex Coherent Anti-Stokes Raman Scattering (CARS), to enable remote explosives detection; explore infrared photothermal technique used in conjunction with laser Doppler vibrometry for energetic-related material detection; and simulate and characterize advanced optical components in a threat detection device for active protection defeat of both kinetic energy and non-kinetic energy targets. ***FY 2016 Plans:*** Will 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	2.316	1.287	1.128

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
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.			
Title: Power and Thermal Management for Small Systems	3.415	3.378	3.374
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 2014 Accomplishments:** Established models for package-integrated thermal solutions to balance continuous and transient loads in electronic substrates; assessed emerging thermoelectric materials and modules for power generation under the high temperature conditions required for efficient direct power generation or waste heat recovery; characterized catalysts for fuel conversion (JP-8 and alternative fuels) to build reaction models for efficient combustion design; investigated improved interconnects between solar cells with gallium nitride materials with advanced structures and interfaces to lower the resistance and thereby improve efficiency of the modules; and investigated new 3D ultra-high density integration process that enable disparate best-of-breed sensors and electronics to be integrated within a single package with minimal packaging overhead and interconnect losses. **FY 2015 Plans:** Investigate heat management techniques for improving engine waste heat recovery; implement techniques for thermal interface measurements to evaluate heat transfer in novel materials; investigate thermoelectric, pyroelectric, and thermophotovoltaic power generation techniques and materials for applicability in direct power generation; characterize advanced materials for improved fuel conversion efficiency and apply them toward developing improved reaction models; investigate improved techniques for wide bandgap material and device design for power supply and conversion systems; and develop improved models and measurement techniques for prediction of silicon carbide device performance and reliability for high power applications. **FY 2016 Plans:** Will implement techniques for thermal interface measurements to evaluate 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.			
Title: Emerging Electronic Devices and Circuits	2.080	2.050	1.681

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Description: This effort investigates and evaluates 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 2014 Accomplishments:* Designed and developed devices and integrated circuits based upon leading edge group IV and III-V semiconducting materials and nanoelectronic approaches; and developed specialized approaches to accommodate extreme environment operation (built-in self-test, ultra-high power/high thermal stress, etc.). *FY 2015 Plans:* Mature 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 semiconducting materials; and investigate emerging electronics and prognostics and diagnostics strategies for microgrid energy and power applications. *FY 2016 Plans:* Will 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.			
Title: Advanced Infrared Technology (previously titled Infrared (IR) Imaging) *Description:* This effort designs and evaluates materials, components and focal plane arrays (FPA) for the next generation of Army's night vision systems, missile seekers, and general surveillance devices. Technologies investigated include mercury cadmium telluride (HgCdTe) 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 focal plane arrays. Work accomplished under PE 0602709A/ project H95 and PE 0601120A/project 31B complements this effort. *FY 2014 Accomplishments:* Model and exploit electromagnetic resonant effects to design and fabricate high quantum efficiency (up to 70%), large format, long wavelength, quantum well infrared photo-detector focal plane arrays with resolution up to 4 megapixel or higher; develop high quality scalable substrates with cadmium (zinc, selenium) telluride buffer layers on silicon substrates; and develop mercury cadmium (telluride, selenide) based infrared sensing materials and devices; and use thermal cycle annealing to reduce dislocations propagating in the active region, which currently limits operability. *FY 2015 Plans:*	2.410	2.593	2.575

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
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 2014	FY 2015	FY 2016
Develop high quality scalable substrates with cadmium (zinc, selenium) telluride buffer layers on silicon substrates and develop HgCdTe material in collaboration with industrial partners; further study thermal cycle annealing of HgCdTe IR detecting material to advance the development of low cost, dual-color, high performance night vision detectors; and develop and test high quantum efficiency, high definition resonant quantum well IR photodetector QWIP (R-QWIP) arrays for dualband longwave/midwave infrared (LWIR/MWIR) imaging. *FY 2016 Plans:* Will investigate extremely low-doped HgCdTe IR material grown on domestically available lattice matched substrates for different spectral regions, including short wavelength IR (SWIR) and long wavelength IR (LWIR) applications; study effects of thermal cycle annealing on HgCdTe material as it pertains to dopant species and profiles; study the implementation of resonant features on HgCdTe for higher temperature operation; and characterize and analyze R-QWIP material and devices for improved quantum efficiency and operating temperature.			
Title: Power and Energy *Description:* This effort designs and evaluates chemistries, materials and components for advanced batteries, fuel reformers, and fuel cells. Potential applications include hybrid power sources, smart munitions, hybrid electric vehicles, and Soldier power applications. Investigate applicability of photosynthesis to provide fuel and electricity for Soldier power applications. Investigate silicon carbide (SiC) power module components to enable compact high efficiency, high temperature, and high power density converters for motor drive and pulse power applications. *FY 2014 Accomplishments:* Evaluated thin film thermal batteries; experimentally validated computational models of hydroxyl-ion transport in alkaline membranes for alkaline fuel cells; evaluated lithium/sulfur battery chemistry for grid energy storage, investigated solid electrolyte interphase formation on silicon anodes for lithium ion batteries; demonstrated production of hydrogen gas using photosynthetic methods for alternative energy applications; continued to evaluate and characterize material defects and interface impedances using a diode structure to improve the reliability of electronic power devices; and investigated and characterized high frequency operation of silicon carbide devices for new device material implementation in vehicle motor drives and pulse power applications. *FY 2015 Plans:* Transition thin film thermal batteries to U S. Army Armament Research, Development and Engineering Center (ARDEC) for augmented munitions power; determine transport properties of anion exchange polymers for alkaline fuel cells; investigate components for sodium ion batteries, optimize electrolyte composition for silicon anodes for lithium ion batteries, develop three dimensional (3-D) strategies for photosynthetic production of hydrogen for alternative energy applications; and experimentally validate models developed through the multiscale modeling effort for batteries and fuel cells; and investigate gallium nitride	4.010	3.972	3.971

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
material based devices in addition to silicon carbide based Metal Oxide Semiconductor Field Effect Transistors (MOSFETs) for reliability and operability characterization. *FY 2016 Plans:* Will evaluate and transition 5-volt lithium ion battery electrodes and electrolytes for development of an sample cell for laboratory testing and evaluation; 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.			
Title: Sensor Protection Technologies ***Description:*** This research will develop technologies to specifically address laser threats at different frequencies (ultraviolet, infrared, etc.) and at a variety of pulse widths (picosecond, femtosecond). This research will develop technologies to protect Army radars by agile spectrum exploitation, reconfigurable high speed switching technology, and novel RF power limiters and switching devices to protect RF front ends in contested environments as well as from self-interference challenges where multiple RF systems are operating in close proximity. *FY 2015 Plans:* Investigate non-linear electro-optical materials and devices for use in a broad range of sensors, UV, MWIR, and LWIR against very short pulse (down to femtosecond) laser threats; investigate materials and novel devices to delay the onset of thermal destruction of optics and optical structures from high energy lasers; improve laser protection by exploring fast EO shutters, using inorganic crystal-based materials, in conjunction with device tiling to provide increased protection for large aperture sensors; and investigate novel electronic materials to support fast switching devices and power dissipation techniques to protect RF front ends. *FY 2016 Plans:* Will 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-wave infrared (SWIR) and mid-wave infrared (MWIR) sensor protection; investigate new techniques for protection against continuous wave high energy laser threats; and characterize materials as optical limiters against femtosecond pulsed laser threats across a variety of wavelengths (visible through MWIR).	-	2.000	1.600
Title: Energy Harvesting ***Description:*** This research develops technologies to substantially reduce the number of batteries required to operate electronics needed to accomplish dismounted Soldier/Squad mission objectives, significantly reducing Soldier-borne load and reducing logistics requirements. Research will explore technologies to harvest electrical power by converting and storing energy via	-	1.568	2.340

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
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 2014	FY 2015	FY 2016
engineered structures and electronic bandgaps, MEMS-based microscale power conversion and heterogeneous 3D assembly of MEMS with other devices to enable efficient distributed power conversion. Research explores novel paths to local fuel and energy production, including artificial photosynthesis to extract hydrogen and electricity directly from water and sunlight. *FY 2015 Plans:* Explore novel thermophotovoltage devices to achieve high efficiency conversion considering available microcombustors and wavelength-optimized semiconductor devices; investigate plasmonic and meta-materials for enhanced surface catalysis experiments for enhanced energy harvesting from battlefield-scavenged resources; explore options for reducing parasitic losses for military thermoelectrics; and examine pyroelectric materials and models to determine suitability for energy harvesting. *FY 2016 Plans:* Will study the properties of bandgap engineered indium gallium nitride (InGaN) and highly mismatched alloys to develop the capability to split water to produce hydrogen to use for fuel or as intermediates for fuel; evaluate 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.			
Accomplishments/Planned Programs Subtotals	29.438	30.908	30.212

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army | **Date:** February 2015

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

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
Total Program Element	-	42.624	44.935	33.807	-	33.807	35.556	37.081	37.300	38.031	-	-
H95: *Night Vision And Electro-Optic Technology*	-	42.624	38.435	33.807	-	33.807	35.556	37.081	37.300	38.031	-	-
K90: *NIGHT VISION COMPONENT TECHNOLOGY (CA)*	-	-	6.500	-	-	-	-	-	-	-	-	-

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. In FY11 through FY16 the Army investment in advanced IR FPA technologies is augmented to ensure a world-wide technological and competitive IR sensor advantage for the United States.

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 U.S. Army Communications-Electronics Research, Development and Engineering Center (CERDEC)/Night Vision and Electronic Sensors Directorate (NVESD), Fort Belvoir, VA.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army			Date: February 2015		
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*			**R-1 Program Element (Number/Name)** PE 0602709A I *Night Vision Technology*		
B. Program Change Summary ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**
Previous President's Budget	43.403	38.445	37.134	-	37.134
Current President's Budget	42.624	44.935	33.807	-	33.807
Total Adjustments	-0.779	6.490	-3.327	-	-3.327
• Congressional General Reductions	-	-0.010			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	6.500			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.779	-			
• Adjustments to Budget Years	-	-	-3.327	-	-3.327

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2014**	**FY 2015**
Project: K90: *NIGHT VISION COMPONENT TECHNOLOGY (CA)*		
Congressional Add: *Program Increase*	-	6.500
Congressional Add Subtotals for Project: K90	-	6.500
Congressional Add Totals for all Projects	-	6.500

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army									**Date:** February 2015	
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602709A *I Night Vision Technology*				**Project (Number/Name)** H95 *I Night Vision And Electro-Optic Technology*		

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
H95: *Night Vision And Electro-Optic Technology*	-	42.624	38.435	33.807	-	33.807	35.556	37.081	37.300	38.031	-	-

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. Component technologies include novel focal plane arrays (FPAs), processing and electronics improvements, and modeling and simulation to predict performance and to determine operational effectiveness. This 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 very large format IR FPAs needed for sensors to simultaneously provide wide area coverage and the high resolution for situational awareness, persistent surveillance and plume/gunflash detection. In addition this project develops multispectral and hyperspectral algorithms for on-chip hyperspectral functionality, which offer the ability to perform detection, identification and signature identification at extended ranges as well as the ability to detect targets in "deep hide". Reducing size, weight and power (SWaP) is a key research objective for all efforts. In FY11 through FY16 the Army investment in advanced IR FPA technologies is augmented to ensure a world-wide technological and competitive IR sensor advantage 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 PE is performed by the U.S. 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 2014	FY 2015	FY 2016
Title: Distributed Aided Target Recognition (AiTR) Evaluation Center of Excellence	1.761	1.801	1.794

Description: This effort researches a Defense-wide virtual/distributed capability to interactively process both real and generated 3-Dimension (3D) multispectral scenes from sensor simulations. Automatic target recognition (ATR) and aided target recognition (AiTR) algorithms are evaluated against realistic operational scenarios in aided or fully autonomous reconnaissance, surveillance and target acquisition (RSTA) missions to include roadside threats/explosively formed projectiles.

FY 2014 Accomplishments:
Investigated and evaluated target tracking algorithms through image based detection and confirmation processing to reduce false alarms and lost target tracks for persistent surveillance and airborne sensor systems; investigated signal processing and

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
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 2014	FY 2015	FY 2016
algorithms for threat detection and tracking that minimizes power consumption, enabling the use of smaller processors in size, weight, and power (SWaP) constrained environments. **FY 2015 Plans:** Investigate algorithmic correlation approaches to further reduce false alarms in image based detection and confirmation processing for vehicle systems; design and develop improved technology for multifunction display capability; continue to 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:** Will 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.			
Title: Sensor Modeling and Simulation Technology **Description:** This effort investigates, verifies and validates engineering models, measurement techniques and realistic simulations concurrently with the development and transition of core sensor technologies. The goal of sensor modeling and simulation technology is to improve the fidelity and adaptability of in-house modeling and simulation capabilities for the purposes of 1) Warfighter training 2) sensor system analysis 3) identifying and addressing phenomenology associated with imaging technologies and 4) perception lab-based model target task calibration of imaging technologies. **FY 2014 Accomplishments:** Expanded the engineering models, measurements and simulations to address new and emerging sensor capabilities, modalities and target threats; researched and incorporated additions to the predictive engineering sensor performance model to include sub-pixel targets, cooperative sensors, measures of persistence and Three-Dimensional (3D) target rendering; provided calibrated, Infrared (IR) target signatures (human, Improvised Explosive Device (IED), vehicles) to simulations used for sensor development, training and wargaming; developed and performed perception testing procedures to refine combatant/non-combatant sensor performance related to activity and motion and to document effects of 3D target rendering and displays on human decision; designed, implemented and published laboratory measurement standards for new technologies including color/false color imaging, fused imaging across Electro-Optic/Infrared (EO/IR) bands and 3D displays. **FY 2015 Plans:** Research and incorporate sensor performance model and measurement techniques to validate the optimal implementation of target and background signatures in simulation; compare laboratory and field measurements to determine if any errors are	5.057	5.222	5.222

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602709A *I Night Vision Technology*	**Project (Number/Name)** H95 *I Night Vision And Electro-Optic Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
introduced by methodology; validate and measure imagery post processing algorithms and subsequent effects on human performance; research phenomenology and application of imaging sensor modalities across the waveband spectrum, to include 3D imaging and displays. ***FY 2016 Plans:*** Will 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 sensors systems; research new techniques and implementation methods such as virtual prototyping to support evolution of the modeling and simulation tools development.			
Title: Advanced Multifunction Laser Technology ***Description:*** This effort investigates technology for a new class of multi-wavelength laser modules which will replace multiple laser systems and reduce the size, weight and cost 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 drastic reduction in the Size, Weight, and Power (SWaP) of multi-function laser systems, as well as reduction in the logistics inherent in deploying multiple systems. ***FY 2014 Accomplishments:*** Investigated technology for a single source of multifunction, eye-safe fiber lasers operating in the Short Wave Infrared Band (SWIR, 1.5 to 2.0 microns); designed a single laser for multiple applications in a compact package to perform laser range finding, day/night pointing, and 3-Dimensional (3D) Light Detection and Ranging (LIDAR) imaging. ***FY 2015 Plans:*** Design a multifunction SWIR laser breadboard that performs range finding, day-night pointing, and 3D LIDAR; extend the laser operating wavelength to Long Wave Infrared (LWIR) by examining alternative laser technology including quantum cascade lasers; research methods for electronically tuning waveband throughout the Long Wave Infrared (LWIR) band; research and improve laser diode drivers and associated electronics to improve efficiency and power consumption. ***FY 2016 Plans:*** Will 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.	4.137	5.276	5.276
Title: High Performance Small Pixel Uncooled Focal Plane Array (FPA)	3.007	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
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 2014	FY 2015	FY 2016
Description: This effort increases the working performance of both uncooled Longwave Infrared (LWIR) and Shortwave Infrared (SWIR) technologies. Through design and improved fabrication techniques this work increases detector resolution to high definition formats (LWIR-1920x1200 pixels, SWIR- 1280x720 pixels), improves sensitivity and image quality to increase recognition and identification ranges while reducing Size, Weight, and Power (SWaP). *FY 2014 Accomplishments:* Completed full performance characterization of the High Definition (HD) 1920 x 1080 pixel uncooled LWIR FPA camera; fabricated the final lot of HD uncooled LWIR FPA and demonstrated in a camera for long range target identification; characterized a high performance uncooled hyperspectral SWIR FPA (1280 x 720 pixel) for detection of difficult targets in high cluttered background.			
Title: Advanced Structures for Cooled Infrared (IR) Sensors *Description:* This effort researches detector materials and substrates for IR sensors. The emphasis is on reducing material defects and increasing the reliability by means of new ways to prepare and treat the substrates and new designs and methods of growing the structures. The goal is to develop cost effective components for high definition Army IR sensors. *FY 2014 Accomplishments:* Validated indium bump process for high definition format Focal Plane Arrays (FPAs); researched advanced steep sidewalled plasma etching for dual band structures for high definition FPAs, which provided more pixels on target, increased resolution and higher quality images, thus enabling a reduction in defects. *FY 2015 Plans:* : Investigate new growth methods for improving the uniformity and reducing the cost of very Long Wave Infrared (LWIR) (wavelength greater than 11 microns) III-V and II-VI materials; investigate new techniques for passivating LWIR III-V small pixel structures; mitigate effects of initial substrate condition and processing on resulting performance; design and validate read-out circuits appropriate for these FPAs. *FY 2016 Plans:* Will 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 Short Wave Infrared (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.	4.612	5.762	5.763
Title: Digital Readout Integrated Circuit (ROIC) *Description:* This effort investigates and designs new Digital Readout Integrated Circuit (DROIC) technology (digital-in-pixel) enabling the affordable very large format and multiband IR FPAs. The digital-in-pixel results in increased signal storage available	2.609	-	-

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602709A *I Night Vision Technology*	**Project (Number/Name)** H95 *I Night Vision And Electro-Optic Technology*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
to collect incoming signal information from the scene, compared to traditional analog techniques. DROIC is an important component in reducing the overall IR sensor cost and SWaP by allowing much smaller FPA pitch. The increased storage improves dynamic range for targeting, situational awareness and persistent surveillance applications. *FY 2014 Accomplishments:* Researched and developed a high-definition, digital-in-pixel ROIC with on-chip signal processing for a 12 micron, 1280x720 pixel array; validated the DROIC performance (e.g. high dynamic range and low noise) using a well characterized 640x480, 20 micron pixel array.			
Title: Enhanced IR Detector ("nBn") Technology *Description:* This effort investigates and improves a new barrier detector structure that makes Mid Wave Infrared Focal Plane Arrays (MWIR FPAs) easier and more affordable to manufacture and allows operation at higher temperatures resulting in much more affordable sensor systems and also significant reductions in Size, Weight, and Power (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. *FY 2014 Accomplishments:* Researched and developed 2000x2500 8 micron pitch and 4000x4000 10 micron pitch FPAs, resulting in a higher resolution, smaller size array; validated resulting FPA structures and investigated techniques to increase yield by reducing defect formation; conducted comparison studies between single very-large-format versus multiple large-format FPAs by examining FPA pitch size, FPA format, butting issues and IR system interfaces and performance relationships; began research on very small pitch (5-6 micron) ROIC and FPA designs. *FY 2015 Plans:* Research and develop 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; develop processing and hybridization for 8 micron pixel FPAs.	7.869	3.389	-
Title: Strained Layer Superlattices (SLS) Technology *Description:* This effort investigates and improves III-V material (materials formed by a combination of elements from group III and V of the periodic table) thin film crystal growth of Infrared Focal Plane Arrays (IR FPAs) using a very flexible Strained Layer Superlattice (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.	5.369	4.141	-

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015
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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
FY 2014 Accomplishments: Fabricated 1280x720, 12 micron pitch, dual-band Mid Wave/Long Wave (MW/LW) IR FPAs on 4 inch Gallium Antimonide (GaSb) and Gallium Arsenide (GaAs) substrates; resolved the substrate flatness and detector passivation issues; began material growth and assess the material quality on 6 inch GaSb and GaAs substrates.			
FY 2015 Plans: Verify 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; extend cutoff wavelength device designs to 11.5 and 13.5 microns.			
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 US Warfighter. This effort is fully coordinated with PE 0603710A. *FY 2014 Accomplishments:* Designed waveguide optical components with multiple approaches including time domain switchable materials for head mounted and vehicle mounted applications; designed and developed color low light solid state silicon focal plane to determine optimum color filter array spectral requirements, matured patterned interference filter coating technology for sub-10 micron pixel spacing and conducted experiments on tactical target low light color phenomenology. *FY 2015 Plans:* Integrate waveguide optical components into head wearable form factors for limited data collections and Soldier perception testing; validate ability of large area waveguide virtual displays to provide the space stabilized display in scenes with jitter; fabricate and integrate color low light solid state silicon focal plane as a test platform; determine optimum color filter array spectral requirements; improve patterned interference filter coating technology for sub-10 micron pixel spacing; conduct experiments on tactical target low light color phenomenology.	5.136	5.912	-
Title: Solid State Low Light Imaging *Description:* This effort develops true starlight and very low light sensing, solid state focal plane technology with reduced power and production cost for Soldier vision enhancement for deficient visibility conditions. The objective of this effort is an all solid state near- Infrared (IR) sensor for replacement of current Image Intensifier (I2) vacuum tube technology to include a new	3.067	4.872	4.971

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602709A *I Night Vision Technology*	**Project (Number/Name)** H95 *I Night Vision And Electro-Optic Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Complementary Metal Oxide Semiconductor (C-MOS) based sensor technology which can be integrated with new 3-Dimensional (3D) Digital Read-Out Integrated Circuit (DROIC) technology. ***FY 2014 Accomplishments:*** Investigated and developed an all solid state low light imaging architecture with sensor, processor and display in a monolithic stacked design to replace analog vacuum tube based image intensifier; developed ultra-low dark current, high quantum efficiency silicon FPA fabrication processes in a US micro-electronic foundry. ***FY 2015 Plans:*** Optimize pixel size and develop back-side illuminated silicon processes for near IR resolution comparable to current I2 technology; develop through silicon via processing capability for 3D stacking of small pixel silicon FPAs; investigate back-end processing techniques for stacking FPAs with electronics and displays; conduct design studies to determine image processing techniques required for low latency night imaging. ***FY 2016 Plans:*** Will 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 Plans:*** Investigate incorporation of algorithms for improved SA and mobility in DVE; develop low power processing techniques for improved imaging through DVE.	-	2.060	-
Title: 3-Dimensional (3D) Micro-Electronics for Night Vision Sensors ***Description:*** The goal of this 3D Micro Electronics effort is to research new reconfigurable optics and display technologies to interface with emerging 3D electronics processing. The ability to actively reconfigure optical elements will require research into new materials and lens designs to enable real time optical refocusing and extended fields of view. Microdisplay 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.	-	-	5.913

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602709A *I Night Vision Technology*	**Project (Number/Name)** H95 *I Night Vision And Electro-Optic Technology*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
FY 2016 Plans: Will 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 diodes (OLEDs) materials which offer luminance and multi sensor input for sensor visualization with a 3D Digital Readout Integrated Circuit (DROIC) interface.			
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 2D & 3D DROICs to replace legacy 2D analog ROICs. This effort will investigate, research and design digital readout architecture optimized for large format, small pixel pitch, high performance cooled and uncooled Infrared (IR) FPAs through the use of modeling, analysis, simulations, layouts, empirical testing and fabrication. If successful, this enabling technology will bring substantial improvement in IR imaging capabilities. ***FY 2016 Plans:*** Will 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.	-	-	4.868
Accomplishments/Planned Programs Subtotals	42.624	38.435	33.807

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
K90: *NIGHT VISION COMPONENT TECHNOLOGY (CA)*	-	-	6.500	-	-	-	-	-	-	-	-	-

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 2014**	**FY 2015**
Congressional Add: Program Increase	-	6.500
FY 2015 Plans: Program increase for night vision technology research.		
Congressional Adds Subtotals	-	6.500

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army											**Date:** February 2015	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					**R-1 Program Element (Number/Name)** PE 0602712A *I Countermine Systems*							
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
Total Program Element	-	30.019	29.428	25.068	-	25.068	26.497	26.663	26.996	27.531	-	-
H24: *Countermine Tech*	-	17.038	20.900	19.445	-	19.445	20.821	20.930	21.238	21.658	-	-
H35: *Camouflage & Counter-Recon Tech*	-	2.981	5.028	5.623	-	5.623	5.676	5.733	5.758	5.873	-	-
HB2: *COUNTERMINE COMPONENT TECHNOLOGY (CA)*	-	10.000	3.500	-	-	-	-	-	-	-	-	-

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-sensors capabilities. The focus is on 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 reconnaissance capabilities of the enemies. 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 U.S. Army Research, Development and Engineering Command (RDECOM)/Communications-Electronics Research, Development and Engineering Center (CERDEC)/Night Vision and Electronic Sensors Directorate (NVESD), Fort Belvoir, VA.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army				**Date:** February 2015	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*			**R-1 Program Element (Number/Name)** PE 0602712A I *Countermine Systems*		

B. Program Change Summary ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**
Previous President's Budget	30.563	25.939	25.251	-	25.251
Current President's Budget	30.019	29.428	25.068	-	25.068
Total Adjustments	-0.544	3.489	-0.183	-	-0.183
• Congressional General Reductions	-	-0.011			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	3.500			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.544	-			
• Adjustments to Budget Years	-	-	-0.183	-	-0.183

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2014**	**FY 2015**
Project: HB2: *COUNTERMINE COMPONENT TECHNOLOGY (CA)*		
Congressional Add: *Unexploded Ordinance and Landmine Detection Research*	10.000	-
Congressional Add: *Program Increase*	-	3.500
Congressional Add Subtotals for Project: HB2	10.000	3.500
Congressional Add Totals for all Projects	10.000	3.500

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army | **Date:** February 2015

| 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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
H24: *Countermine Tech*	-	17.038	20.900	19.445	-	19.445	20.821	20.930	21.238	21.658	-	-

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 goal of this project is 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 U.S. Army Communications-Electronics Research, Development and Engineering Center (CERDEC)/Night Vision and Electronic Sensors Directorate, Fort Belvoir, VA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Department of Defense Unexploded Ordnance (UXO) Center of Excellence (UXOCOE) **Description:** The Army serves as executive agent of the Unexploded Ordnance (UXO) Center of Excellence (COE), which provides for the coordination of UXO activities across the Department of Defense (DoD) Army, Navy, Air Force and Marine Corps programs. The UXOCOE serves as the focal point for research, development, testing and evaluation (RDT&E) for UXO detection, clearance technologies, remediation and sensor/signature/DOD program database development. Technologies investigated for mitigating UXO are oriented to land and underwater approaches. **FY 2014 Accomplishments:** Researched a high power laser neutralization source that enables safe standoff removal of wire obstacles while on the move.	0.453	-	-
Title: Standoff Sensors for Explosive Hazard Detection **Description:** This effort addresses the challenges of sensing and confirming potential in-road and/or roadside targets at standoff range such as reduced resolution and grazing angle effects. This effort focuses on understanding phenomenologies that impact sensor design concepts and steer novel technologies that provide primary anomaly search sensing leading to higher-confidence target detection and clutter/background filtering. Examples of candidate technologies include forward looking Electro-Optic/Infrared (EO/IR) and Ground Penetrating Radar (GPR) sensors for surface and shallow buried targets. These efforts also investigate new sensor phenomenologies to confirm buried threats at deeper depths including multispectral, low frequency electro-magnetic (EM), and doppler interferometric sensors.	7.359	5.409	9.961

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army			Date: February 2015		
Appropriation/Budget Activity 2040 *I* 2		R-1 Program Element (Number/Name) PE 0602712A *I Countermine Systems*		Project (Number/Name) H24 *I Countermine Tech*	

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
FY 2014 Accomplishments: Validated designs of component antenna arrays and conducted experiments for a multi-band forward looking GPR; investigated EO forward projecting Laser Radar (LADAR) to assist forward looking radar; developed advanced detection algorithms utilizing high resolution surface terrain information obtained from the integration with LADAR; conducted field data collections of standoff vibration technology in combination with the EM, electromagnetic interference (EMI) and EO based sensor for detection of shallow and deeply buried explosive hazards; enhanced visualization workstation software to incorporate available sensor inputs in real time. *FY 2015 Plans:* Integrate dual band Forward Looking (FL) GPR and EO/IR sensors on a brassboard demonstrator; conduct phenomenology studies to determine feasibility of fusion of multiple sensor modalities for improved detection; extend detection depth of low parity Doppler interferometer using seismic sources. *FY 2016 Plans:* Will validate dual band FL GPR components using new phased arrays; explore polarization phenomenologies with Short Wave IR through Long Wave IR sensors to discriminate man-made objects; investigate vibration sensors to distinguish targets from clutter; explore ground profiling sensors (LIDAR, X-band radar) to improve FL GPR data by removing surface clutter; study new identification and confirmation sensors such as autonomous Neutron Gamma sensors.			
Title: Chemically Specific Detection of Explosive Threats *Description:* This effort investigates emerging chemically-specific explosive hazards (to include Home Made Explosives (HMEs)) and detection technologies to address Warfighter needs. The effort will provide technologies for standoff detection and confirmation of emerging threats and production facilities and is complimentary to the work being accomplished under PE 0602622A/Project 552. *FY 2014 Accomplishments:* Investigated and validated standoff spectroscopic technologies capable of detecting explosive hazards and HME production facilities; conducted technical experiments using eye safe, low-Size, Weight, and Power (SWaP), Quantum Cascade Laser (QCL) technology to effectively sample the residues for trace amounts of explosives for identification and standoff illumination for disturbed earth detection. *FY 2015 Plans:* Improve algorithms and signal processing to maximize discrimination and reduce false alarms of explosive components; conduct data collections in various conditions to determine detection and identify capabilities against explosive compounds using quantum dots for close proximity sensing and QCLs for stand-off trace detection. *FY 2016 Plans:*	5.834	4.815	2.858

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602712A *I Countermine Systems*	**Project (Number/Name)** H24 *I Countermine Tech*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Will 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.			
Title: Dismounted Explosive Hazard Detection Technology *Description:* This effort investigates threat and common clutter phenomenologies enabling investments in emerging component technologies to enhance detection of explosive hazards, including metallic and non-metallic landmines, Improvised Explosive Devices (IEDs), Home Made Explosives (HMEs), and Explosively Formed Penetrators (EFPs). Emphasis will be on increased coverage area, higher detection and discrimination probabilities. Low Size, Weight, and Power (SWaP) enabling technologies will be considered and studied to ensure solutions are viable for Soldier-portable applications. This effort also investigates advanced signal processing and real time algorithms utilizing candidate sensors including Ground Penetrating Radar (GPR), and metal detector position, for increased real-time feedback on threat detection and enhanced identification. *FY 2014 Accomplishments:* Optimized and validated emerging technologies such as advanced GPR antennas; compact metal detectors with target identification; position measurement sensors and see-thru displays as part of a portable handheld sensor suite for detection of explosive hazards. *FY 2015 Plans:* Conduct laboratory data collections using GPR, wide bandwidth metal detectors, and position measurement sensors mounted in a handheld emulation platform to establish a correlated dataset; conduct experiments to determine highly accurate sensor position to improve display of sweep location and subsurface threats; develop near real-time detection and processing capability; conduct 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:* Will 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, reduce the operator's cognitive burden, and improve clutter rejection.	3.392	5.495	3.626
Title: Explosive Hazard Neutralization Technologies *Description:* This effort investigates emerging neutralization technologies and techniques to effectively neutralize explosive hazards (to include HMEs) to address Warfighter needs. *FY 2015 Plans:*	-	1.181	-

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602712A *I Countermine Systems*	**Project (Number/Name)** H24 *I Countermine Tech*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Investigate fiber laser based techniques for low or high-order neutralization of explosive threats at standoff ranges.			
Title: Counter Explosive Hazard Phenomonology	-	4.000	3.000
Description: This effort investigates potential long term solutions to the asymmetric explosive hazard threats. It leverages recent lessons learned to investigate new ideas and emerging technologies to counter explosive hazards through better understanding, detection, neutralization and mitigation of the threat. *FY 2015 Plans:* Instigate a series of knowledge capture events with industry and academia; develop novel and innovative research efforts in counter-Improvised Explosive Device (IED) detection; begin 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:* Will 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.			
Accomplishments/Planned Programs Subtotals	17.038	20.900	19.445

C. Other Program Funding Summary ($ in Millions)

 N/A

Remarks

D. Acquisition Strategy

 N/A

E. Performance Metrics

 N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army											Date: February 2015	
Appropriation/Budget Activity 2040 I 2				R-1 Program Element (Number/Name) PE 0602712A I Countermine Systems					Project (Number/Name) H35 I Camouflage & Counter-Recon Tech			
COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
H35: Camouflage & Counter-Recon Tech	-	2.981	5.028	5.623	-	5.623	5.676	5.733	5.758	5.873	-	-

A. Mission Description and Budget Item Justification

This project investigates, designs and evaluates advanced signature management and deception techniques for masking friendly force capabilities and intentions. Technologies pursued under this effort reduce the cross section of sensor systems. Technologies such as decentered field lens, wavefront coding and spectral filtering and threat sensing algorithms are investigated along with next generation camouflage coatings and paints.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Camouflage and Counter-Reconnaissance Technology for Advanced Spectral Sensors **Description:** This effort investigates and advances new techniques to reduce Electro-Optical (EO) susceptibility of sensors and camouflage. The two primary objectives are to reduce the optical cross section of currently fielded and emerging EO and Infrared (IR) sensors and investigate technologies that will enable enhanced spectral signature reduction for next generation camouflage. *FY 2014 Accomplishments:* Continued development of solutions to reduce optical cross section of large format (EO/IR) arrays; developed and investigated hardware/software, filters and coatings for currently fielded large format EO and uncooled IR sensors; camouflage effort focused on implementation of thermal signature reduction coatings and methodologies suitable for nets and uniforms. *FY 2015 Plans:* Investigate uncooled Focal Plane Array (FPA) vulnerabilities and exploitation against multiple laser threats; conduct initial studies into adaptive protection for Long Wave (LW) IR sensors; incorporate large format array sensor protection solution into hardware/software demonstrators; evaluate multispectral camouflage to include thermal signature reduction technology. *FY 2016 Plans:* Will 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 laser harden DayTV cameras; investigate methods	2.981	5.028	5.623

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602712A *I Countermine Systems*	**Project (Number/Name)** H35 *I Camouflage & Counter-Recon Tech*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
of laser protection for high performance (cooled) IR sensors, including linear and non-linear optical approaches. Explore spectral response of next generation two sided ultra lightweight camouflage and netting (ULCAN)s as well as different methods to imbed a thermal pattern; optimize the performance of multispectral camouflage to counter emerging threats.			
Accomplishments/Planned Programs Subtotals	2.981	5.028	5.623

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army											Date: February 2015	
Appropriation/Budget Activity 2040 I 2				**R-1 Program Element (Number/Name)** PE 0602712A I Countermine Systems					**Project (Number/Name)** HB2 I COUNTERMINE COMPONENT TECHNOLOGY (CA)			
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
HB2: *COUNTERMINE COMPONENT TECHNOLOGY (CA)*	-	10.000	3.500	-	-	-	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Countermine Systems applied research.

B. Accomplishments/Planned Programs ($ in Millions)

	FY 2014	FY 2015
Congressional Add: Unexploded Ordinance and Landmine Detection Research	10.000	-
FY 2014 Accomplishments: Further developed technologies that address counter-improvised explosive device (IED) requirements attributed to route clearance patrols and entry control points for mounted and dismounted applications. The four thrust areas were Sensors for Explosive Threat Identification (Buried/Concealed Configurations); Standoff Side Attack/Squint Angle Threat Detection; Standoff (Pinpoint) Neutralization; and Advanced Signal and Image Processing.		
Congressional Add: Program Increase	-	3.500
FY 2015 Plans: Program increase for countermine technology research		
Congressional Adds Subtotals	10.000	3.500

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 2016 Army										Date: February 2015	

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

R-1 Program Element (Number/Name)
PE 0602716A *I Human Factors Engineering Technology*

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
Total Program Element	-	21.118	23.778	23.681	-	23.681	23.671	24.034	24.636	25.094	-	-
H70: *Human Fact Eng Sys Dev*	-	21.118	23.778	23.681	-	23.681	23.671	24.034	24.636	25.094	-	-

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 U.S. Army Research Laboratory (ARL), Aberdeen Proving Ground, MD.

B. Program Change Summary ($ in Millions)

	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Previous President's Budget	21.328	23.783	23.822	-	23.822
Current President's Budget	21.118	23.778	23.681	-	23.681
Total Adjustments	-0.210	-0.005	-0.141	-	-0.141
• Congressional General Reductions	-	-0.005			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.210	-			
• Adjustments to Budget Years	-	-	-0.141	-	-0.141

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army										Date: February 2015	

Appropriation/Budget Activity 2040 I 2	R-1 Program Element (Number/Name) PE 0602716A I Human Factors Engineering Technology	Project (Number/Name) H70 I Human Fact Eng Sys Dev

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
H70: Human Fact Eng Sys Dev	-	21.118	23.778	23.681	-	23.681	23.671	24.034	24.636	25.094	-	-

Note
Not applicable for this item.

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 portfolio.

Results of these efforts are transitioned to the Research, Development, and Engineering Centers, the Program Executive Offices (PEO) & Program Managers, U.S. Army Training and Doctrine Command (TRADOC), U.S. Army Medical Command (MEDCOM), Manpower and Personnel Integration (MANPRINT) G1, U.S. Army Test and Evaluation Command (ATEC), etc.

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 U.S. Army Research Laboratory (ARL), Aberdeen, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Interfaces for Collaboration and Decision Making	3.324	3.361	2.711
Description: Beginning in FY14, the title of this effort is renamed from Adaptive Learning Methods and Strategies to Interfaces for Collaboration and Decision Making to more accurately reflect the current nature of the project. 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,			

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602716A *I Human Factors Engineering Technology*	**Project (Number/Name)** H70 *I Human Fact Eng Sys Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
will investigate the effects of technology on information flow, cognitive workload, team collaboration, organizational effectiveness, situational awareness, and decision making.			

FY 2014 Accomplishments:
Concentrated on influencing network-enabled operations at the Company level; assessed mission command work/information flow, network knowledge requirements, cognitive workload, situation awareness, and unit performance; developed and validated a cognitive work analysis/computational model of the Company Intelligence Support Team and its relationship to Company planning, execution and Commander's decision-making; assessed networked handheld decision support tools; continued development and validation of key models (Social Network Analysis, Command, Control and Communication Techniques for Reliable Assessment of Concept Execution (C3TRACE), and Chemical Warfare Agents) of the evolving mission command work domain; supported Mission Command Battle Lab network simulation exercises.

FY 2015 Plans:
Examine 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; enhance experimental platforms for studying mission command network operations in civil-military scenarios. Goals are to develop techniques for improved information sharing, more effective use of available information, and new and enhanced metrics and methods leading to a better understanding of how human-network interactions impact distributed team performance. Research is 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:
Will 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 2014	FY 2015	FY 2016
Title: Human Performance Modeling	3.494	3.521	2.672

Description: Enhance human performance modeling tools 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 PE 0602786/project H98.

FY 2014 Accomplishments:

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015	
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602716A *I Human Factors Engineering Technology*	**Project (Number/Name)** H70 *I Human Fact Eng Sys Dev*	

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Collected and analyzed empirical data to support human and system performance models used for equipment design and training; continued to investigate the effects of physical and cognitive stress on Soldier performance, and transitioned results to Soldier performance models; investigated Soldier load physical and cognitive algorithms developed in FY13 and their application to the human performance models; and examined human performance as a function of cognitive stress, weapon system dynamics, load distribution, etc. *FY 2015 Plans:* Develop Human System Integration (HSI) tools and methodologies to quantify the usability of systems developed to support team environments. These tools provide quantitative data that can be used to support acquisition and design trade off decisions. Research is 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:* Will 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 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 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.			
Title: Brain-Computer Interaction **Description:** Beginning in FY14, this effort was renamed from Interfaces for Vehicle and Mobility Systems to Brain-Computer Interaction Technologies to more accurately reflect the nature of the project, a 6.2 program in neuroscience. 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 2014 Accomplishments:* Developed mitigation techniques for enhancing Soldier-system performance that can be triggered by on-line brain-computer neuro-technologies that predicts deficits in Soldier cognitive state and performance. *FY 2015 Plans:*	2.256	2.278	3.338

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015		
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 2014**	**FY 2015**	**FY 2016**
Develop and mature brain-computer interaction technology for image analysis that is capable of adapting to the user for increased joint Soldier-system performance. *FY 2016 Plans:* Will investigate novel approaches for image analysis that fuse computer vision and brain-computer interaction technologies for enhanced target identification capabilities.			
Title: Dismounted Soldier Performance	5.306	6.354	6.204
Description: Beginning in FY14, this effort was renamed from Improved Man Machine Interfaces to Dismounted Soldier Performance in order to more accurately reflect the nature of the project. 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 2014 Accomplishments:* Conducted applied research and analysis on the effects of physical and cognitive loads on Soldier performance for step-wise improvements in equipment design that will contribute incrementally to lightening the Soldier load; characterized effects of weapon recoil on shooting performance by refining multivariate techniques/analyses regarding marksmanship performance; and transitioned results to Army Marksmanship Unit. *FY 2015 Plans:* Expand applied research and analysis on the effects of physical and cognitive loads on Soldier performance to more operationally relevant environments; determine and mature 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; apply techniques developed for quantifying the effects of weapon recoil on shooter performance to a broader area of research (such as the effects of small arms equipment on marksmanship performance); and transition results to the U.S. Army Marksmanship Unit. *FY 2016 Plans:* Will 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.			
Title: Human-Robot Interaction (HRI)	4.530	4.242	3.164

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015

| **Appropriation/Budget Activity**
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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Description: Develop human-centered design requirements and technologies for supervision and Soldier interaction with multiple semi-autonomous unmanned vehicles in urban and unstructured environments. ***FY 2014 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 2015 Plans:*** Continue 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:*** Will 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.			
Title: Understanding Socio-cultural Influence ***Description:*** Investigate and model cognitive aspects of socio-cultural influences on Soldier/Commander decision making and communication to enhance Soldier performance with systems, within teams and in the mission context. Extend models of individual and teams to societal levels to support regional understanding, training, mission rehearsal, and influence. This work complements and is coordinated with PE 0602784/project T41 (Socio-Cultural Modeling) and PE 0602785/project 790 (Leader Development). ***FY 2014 Accomplishments:*** Developed proof-of-concept decision support tools that effectively present relevant socio-cultural information to the Soldier/ Commander to enhance Soldier/Commander decision making in diverse environments. ***FY 2015 Plans:*** Validate cognitive framework and proof of concept decision support tools; develop guiding principles for the presentation of socio-cultural information using validated cognitive framework; initiate extension of cognitive framework to encompass societal-level perspective leveraging historical OSD-investments; and determine experiment requirements for validation of extension. ***FY 2016 Plans:*** Will 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	1.219	2.022	2.019

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
designed to determine if relevant socio-cultural information is presented effectively to enhance Soldier decision making in diverse environments.			
Title: Incorporating MANPRINT Considerations Early in the Acquisition Process *Description:* Develop system-relevant human performance and human-system interaction requirements for inclusion early in acquisition to ensure that human-system capabilities and limitations are properly reflected and that their associated cost, benefits, and risks are considered during analysis of alternatives when making trade-offs among effectiveness, suitability, and life-cycle costs. *FY 2014 Accomplishments:* Applied promising methodologies to test case scenarios for selected acquisition programs; and calculated the return on investment realized by incorporating MANPRINT considerations early in the acquisition process.	0.989	-	-
Title: Soldier Sensory Performance *Description:* In FY16, the effort described here as Soldier Sensory Performance and the associated funding will be separated from the effort entitled Interfaces for Collaboration and Decision Making. 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:* Will conduct Soldier-centric research on personnel-borne IED detection technologies to characterize operator/system strengths and constrains, 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.	-	-	1.473
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	-	1.000	1.000

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
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. *FY 2015 Plans:* Investigate emerging technologies and target those likely to place significant demands on human operators, in particular intelligent, decision-aiding, and autonomous systems for which transparency and trust are crucial; conduct 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 conduct research on task combinations to determine parameters that may inform the development of training technologies. *FY 2016 Plans:* Will identify user skills that are critical to interacting with intelligent, autonomous systems and appropriate methods for measuring the user's skill level; identify or develop approaches for evaluating the effectiveness of various types of training to conduct select human operator tasks.			
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. 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. *FY 2015 Plans:* Conduct research to identify relative contributions and interactions of factors critical to Soldier and team system performance; work within Human Systems community to identify and prioritize critical human performance MOEs and MOPs; conduct 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 propose modifications to individual measures to account for small team performance. *FY 2016 Plans:*	-	1.000	1.100

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Will develop model-based predictive analyses of Dismounted Infantry (DI) missions that will provide 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 (HSI) and Systems Engineering (SE) inputs to generate critical tasks combinations that provide the necessary analytical data to support cognitive workload measurement, MOEs, and MOPs for DI.			
Accomplishments/Planned Programs Subtotals	21.118	23.778	23.681

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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| Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army | | | | | | | | | | | **Date:** February 2015 | |

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

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
Total Program Element	-	22.333	15.653	20.850	-	20.850	22.151	22.640	22.765	23.141	-	-
048: *Ind Oper Poll Ctrl Tec*	-	2.106	1.567	2.341	-	2.341	2.718	2.848	2.886	2.949	-	-
835: *Mil Med Environ Crit*	-	6.035	5.454	7.017	-	7.017	7.803	8.003	8.040	8.196	-	-
895: *Pollution Prevention*	-	6.503	-	3.475	-	3.475	3.474	3.474	3.474	3.474	-	-
896: *Base Fac Environ Qual*	-	7.689	8.632	8.017	-	8.017	8.156	8.315	8.365	8.522	-	-

Note
FY16 increase for pollution prevention efforts.

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 reducing 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 US Army Engineer Research and Development Center, Vicksburg, MS, and the US Army Research, Development and Engineering Command, Aberdeen Proving Ground, MD.

Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army					**Date:** February 2015
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*			**R-1 Program Element (Number/Name)** PE 0602720A *I Environmental Quality Technology*		

B. Program Change Summary ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Previous President's Budget	20.304	15.659	19.087	-	19.087
Current President's Budget	22.333	15.653	20.850	-	20.850
Total Adjustments	2.029	-0.006	1.763	-	1.763
• Congressional General Reductions	-	-0.006			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	2.500	-			
• SBIR/STTR Transfer	-0.471	-			
• Adjustments to Budget Years	-	-	1.763	-	1.763

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army										Date: February 2015	

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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
048: *Ind Oper Poll Ctrl Tec*	-	2.106	1.567	2.341	-	2.341	2.718	2.848	2.886	2.949	-	-

Note
 Not applicable for this item

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 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. 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. Efforts focus on the impacts of new materiel that will enter the Army inventory within the next decade and beyond. This project focuses 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. Efforts abroad include a focus on designing and developing technologies for deployed forces with environmentally safe, operationally enhanced and cost effective technologies and/or processes to achieve maximum diversion, minimization, or volume reduction of base camp and field waste. This project focuses 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 mission.

 The work in this project supports the Army 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 US Army Engineer Research and Development Center, Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)

	FY 2014	FY 2015	FY 2016
Title: Sustainable Ranges and Lands	2.106	1.567	1.401
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 both toward solutions for environmental compliance and associated requirements, as well as solutions that will enhance training and testing operations. *FY 2014 Accomplishments:* Completed field studies and analysis of physiological consequences of wound closure of trees and woody vegetation after burning; compartmentalization and rot resistance for woody species persistence under variable fire regimes; completed			

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602720A *I Environmental Quality Technology*	**Project (Number/Name)** 048 *I Ind Oper Poll Ctrl Tec*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
characterization and forecasting capabilities to assess multi-scale ecological response to altered fire regimes and the consequences for sustainable military land management; completed prescribed fire planning and scenario analysis capabilities to identify burn regime prescriptions that support emissions management; completed a predictive framework for assessing community and ecosystem response to changes in fire regime; refined net zero energy installation optimization algorithms to reduce environmental impacts and to incorporate in the installation energy, water, and waste modeling development in PE 0602784, project T41. *FY 2015 Plans:* Investigate technologies/methods for national, regional and installation Threatened and Endangered Species 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:* Will 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; will investigate innovative techniques for assisted species movement to minimize potential training impacts to Army lands; will 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.			
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:* Will develop and evaluate the next generation of water production and distribution capabilities through the development of wastewater treatment/reuse and water quality monitoring technologies.	-	-	0.940
Accomplishments/Planned Programs Subtotals	2.106	1.567	2.341

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

D. Acquisition Strategy
 N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015
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E. Performance Metrics
 N/A

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Appropriation/Budget Activity 2040 I 2	R-1 Program Element (Number/Name) PE 0602720A I Environmental Quality Technology	Project (Number/Name) 835 I Mil Med Environ Crit

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
835: Mil Med Environ Crit	-	6.035	5.454	7.017	-	7.017	7.803	8.003	8.040	8.196	-	-

Note
Not applicable for this item

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 the 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 that 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 PEO Ammo and 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 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 US Army Engineer Research and Development Center, Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Life Cycle of Military Materials in the Environment	2.531	3.318	4.346
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 2014 Accomplishments:** Developed a web-based visualization tool that provides a framework for assessing multi-stressor climate change impacts to current military installations management objectives; developed new analytical techniques to detect and identify contaminants in			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army			Date: February 2015	
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 2014	FY 2015	FY 2016
the battlefield providing quantitative or semi-quantitative chemical and biological values for operational decision-making (in FY13 this work was funded under PE 0602720 Project 896). *FY 2015 Plans:* Develop 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:* Will 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; will develop software tools containing methods and modules for science-based improvements with improved characterization factors for environmental impact of military unique hazardous materials.			
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 2014 Accomplishments:* Developed a risk-based process to quantitatively assess benefit and impact of nanomaterial-based Army products in the environment and computational approaches for the smart design of functional nanomaterials. Results of this research inform nanomaterial remediation technologies. *FY 2015 Plans:* Develop 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:* Will 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; will 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.	2.472	2.136	2.671
Title: Advanced Remediation Technologies	1.032	-	-

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602720A *I Environmental Quality Technology*	**Project (Number/Name)** 835 *I Mil Med Environ Crit*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
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 2014 Accomplishments:* Examined green remediation technologies for common range contaminants (i.e., RDX, TNT, and metals); investigated innovative wastewater treatment technologies for munitions production to improve water quality of surface water and wetlands impacted by development and use of new munitions compounds; developed standardized protocols and analytical methods to generate high quality environmental, biological and chemical risk values for acquisition decision processes.			
Accomplishments/Planned Programs Subtotals	6.035	5.454	7.017

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army										**Date:** February 2015	
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602720A *I Environmental Quality Technology*						**Project (Number/Name)** 895 *I Pollution Prevention*	
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
895: *Pollution Prevention*	-	6.503	-	3.475	-	3.475	3.474	3.474	3.474	3.474	-	-

Note
 Not applicable for this item

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 base camp energy reduction initiatives, elimination of waste streams in contingency operations and toxic metal reductions from surface finishing processes.

Work in this project supports the Army 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.

Technologies developed in this project are fully coordinated and complementary to 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, the Natick Soldier Research, Development and Engineering Center, Natick, MA, and the Tank Automotive Research, Development and Engineering Center, Warren, MI.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Title: Pollution Prevention Technologies	6.503	-	3.475
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.			

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602720A *I Environmental Quality Technology*	**Project (Number/Name)** 895 *I Pollution Prevention*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
FY 2014 Accomplishments: Conventional Ammunition: conducted limited performance evaluation of novel lead-free primer formulations; Rocket and Missile Propellants: explored lead-free alternatives for minimum signature applications; Toxic Metal Reduction: evaluated emerging hexavalent chromium-free processes for generating wear resistant surface coatings.			
FY 2016 Plans: Conventional Ammunition: will develop precision loading processes for novel lead-free primer formulations; Rocket and Missile Propellants: will conduct static motor testing of novel lead-free burn rate modifiers in minimum signature applications; Toxic Metal Reduction: will develop and refine portable hexavalent chromium-free process for generating wear resistant surface coatings.			
Accomplishments/Planned Programs Subtotals	6.503	-	3.475

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army										Date: February 2015	
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602720A *I Environmental Quality Technology*						**Project (Number/Name)** 896 *I Base Fac Environ Qual*	

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
896: *Base Fac Environ Qual*	-	7.689	8.632	8.017	-	8.017	8.156	8.315	8.365	8.522	-	-

Note

Not applicable for this item

A. Mission Description and Budget Item Justification

This project designs and develops tools and identification and assesment 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 S&T 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 US Army Engineer Research and Development Center, Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Sustainable Ranges and Lands ***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 2014 Accomplishments:***	4.120	4.533	3.927

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602720A *I Environmental Quality Technology*	**Project (Number/Name)** 896 *I Base Fac Environ Qual*	

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Developed predictive models and analytical approaches for natural infrastructure response and installation adaptation planning to climate change; (noise management research delayed due to FY14 sequestration reductions); integrated Installation energy, water, and waste modeling algorithms for net zero energy installation optimization efforts in PE 0602784, project T41. *FY 2015 Plans:* Investigate 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; develop advanced decision metrics that quantify climate uncertainty on mission relevant built and natural infrastructure and processes in a manner that is consistent with current Army plans and planning processes; investigate the underlying fundamental physical and ecological processes of these advanced decision metrics and their response to projected climate change. Initiate 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:* Will develop capabilities that incorporate direct and indirect impacts of climate change and related trending dynamic conditions into critical Army enterprise decisions.; will provide a tiered approach to climate change impact assessments that scale from local to national scale applications. Will extend climate change assessment analyses to include maneuver area capacity, live-fire range capacity, and facility operations and maintenance costs. Will develop advanced military noise assessment capabilities that rapidly characterizes military noises, uncertainties, & impacts to allow installations to comprehensively characterize and adaptively manage their noise footprint, impacts, and restrictions.			
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 2014 Accomplishments:* Developed new technologies to predict the environmental fate and transport of contaminants on complex surfaces to improve operational intelligence; characterized and fuse data from ecological parameters, environmental conditions and social dynamics in locations critical for Army missions and operations in support of Combatant Command requirements. *FY 2015 Plans:* Design tools for detecting and modeling the source of emerging threat agents in areas of denied access. This capability will identify and predict fate of unique contaminant threats and provide information about the quality and spatial distribution of water sources at a landscape scale within an operational area. Begin the development of tools to predict soil characteristics and	3.569	4.099	4.090

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602720A *I Environmental Quality Technology*	**Project (Number/Name)** 896 *I Base Fac Environ Qual*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
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), will develop an understanding of soils and contaminates in austere environments; will apply sophisticated genetic algorithms to develop empirical, validated functions correlating soil morphological designations to multidimensional soil geochemical properties.			
Accomplishments/Planned Programs Subtotals	7.689	8.632	8.017

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

Remarks

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army											**Date:** February 2015	

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

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
Total Program Element	-	33.580	33.807	36.160	-	36.160	38.461	38.592	38.989	39.757	-	-
779: *Command, Control And Platform Electronics Tech*	-	13.502	14.681	15.805	-	15.805	17.102	17.363	17.482	17.826	-	-
H92: *Communications Technology*	-	20.078	19.126	20.355	-	20.355	21.359	21.229	21.507	21.931	-	-

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 potentially 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 complimentary 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.

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Exhibit R-2, **RDT&E Budget Item Justification:** PB 2016 Army			**Date:** February 2015		
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*			**R-1 Program Element (Number/Name)** PE 0602782A *I Command, Control, Communications Technology*		

B. Program Change Summary ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**
Previous President's Budget	34.191	33.817	36.423	-	36.423
Current President's Budget	33.580	33.807	36.160	-	36.160
Total Adjustments	-0.611	-0.010	-0.263	-	-0.263
• Congressional General Reductions	-	-0.010			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.611	-			
• Adjustments to Budget Years	-	-	-0.263	-	-0.263

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army											Date: February 2015	
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602782A *I Command, Control, Communications Technology*						**Project (Number/Name)** 779 *I Command, Control And Platform Electronics Tech*		

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
779: *Command, Control And Platform Electronics Tech*	-	13.502	14.681	15.805	-	15.805	17.102	17.363	17.482	17.826	-	-

A. Mission Description and Budget Item Justification

This project researches 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; MC warfighting function advancement and commander-centric capabilities; 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, data transfer, distributed data bases, open system architectures, and integration concepts which contribute to more efficient mobile 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 2014	FY 2015	FY 2016
Title: Battle Space Awareness and Positioning *Description:* This effort investigates positioning (pos), navigation (nav) and timing sensor/integration technologies to provide position, velocity, and time information to support operational and training requirements, especially in Global Positioning System (GPS) denied environments such as those with hostile electro-magnetic interference and other radio frequency (RF) degradation, in buildings, and during subterranean operations. Work being accomplished under PE 0603772A/project 101 compliments this effort. *FY 2014 Accomplishments:* Researched and investigated sensors based on emerging advances in micro-electromechanical systems (MEMS) and exploitation of signals of opportunity (SOO) to reduce dependence upon GPS as a sole navigation source; investigated advanced anti-jam antennas and pseudo-lite sources to protect and enhance weak GPS signals; examined modernized GPS signals for potential	3.689	4.767	3.870

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
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 2014	FY 2015	FY 2016
integration into Army systems; designed, coded and developed interfaces, protocols and software for handheld devices to access secure GPS through emerging modernized code (M-Code) capable GPS chips. *FY 2015 Plans:* Investigate and analyze new sensor technologies for potential navigation and timing applications such as atomic sensors, multi-Global Navigation Satellite Systems (multi-GNSS), emerging SOOs, and MEMS focusing on improvements to individual sensors and methods for improved manufacturing techniques allowing the potential for smaller integrated navigation systems; examine 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; investigate GPS augmentation systems to evaluate compatibility with new 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:* Will investigate MEMS sensors, anti-jam/anti-spoof antennas, multi-GNSS receivers that incorporate M-code capability; research the application of laser-based LIDAR (light-radar) 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.			
Title: Mission Command (MC) Next Generation Technologies (formerly named Command and Control (C2) On-The-Move (OTM) Enabling 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. Work in this effort transitions to PE 0603772A/project 101. *FY 2014 Accomplishments:* Investigated software and developed algorithms to increase unmanned platform autonomy and improve multi-platform autonomous collision avoidance; designed and refined MC systems that learn and adapt based on the users' preferences and mission needs in order to reduce required training; investigated self-forming MC software solutions to reduce setup/tear-down effort and provide some zero-time (initial startup) capability; architected automated troubleshooting tools to reduce MC field service representative support costs and improve system utility; improved upon advanced computing platform display technologies by researching methods of supporting additional points of touch for multiple simultaneous users, and wireless	9.813	9.914	11.935

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015		
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602782A *I Command, Control, Communications Technology*	**Project (Number/Name)** 779 *I Command, Control And Platform Electronics Tech*		

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
interface technology to connect to portable computing devices; architected and designed a portable, tactical, distributed computing and storage solution to manage the distributed system and data to improve command post (CP) mobility and accessibility from vehicles and dismounts; developed and coded a single common cross-platform software interface demonstrator that supports dismounted, mounted, and CP operations to reduce software design and support costs. *FY 2015 Plans:* Research and brassboard the required data, system architectures, and leader tools needed to provide continuously available MC capabilities from tactical through strategic echelons; investigate and design multi-echelon, unified MC software with a particular emphasis on enabling small unit commander-centric operations; design and code MC software that dynamically assesses the mission and the battle space to help maximize mission success by managing limited and distributed resources, including operational energy, bandwidth, and cognitive processing; design and code 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; design 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; design and code 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:* Will 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.			
Accomplishments/Planned Programs Subtotals	13.502	14.681	15.805

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

D. Acquisition Strategy
 N/A

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602782A *I Command, Control, Communications Technology*	**Project (Number/Name)** 779 *I Command, Control And Platform Electronics Tech*

E. Performance Metrics

  N/A

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R-1 Program Element (Number/Name)
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Project (Number/Name)
H92 / Communications Technology

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
H92: Communications Technology	-	20.078	19.126	20.355	-	20.355	21.359	21.229	21.507	21.931	-	-

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 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 2014	FY 2015	FY 2016
Title: Antenna and Hardware Technologies (Formerly named Antenna Technologies)	6.627	3.948	2.787
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			

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 I 2	R-1 Program Element (Number/Name) PE 0602782A I Command, Control, Communications Technology	Project (Number/Name) H92 I Communications Technology

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
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 compliments this effort. *FY 2014 Accomplishments:* Developed optically non-intrusive antenna arrays for transparent Armor; investigated and advanced smart switching for distributed antenna system arrays enabling higher output power, interoperability and improved link connectivity for terrestrial and SATCOM communications and electronic warfare (EW); investigated and evolved antenna systems that provide capacity to support simultaneous EW jamming and communications without interference; established standard interface for distributed terrestrial and SATCOM antenna systems to support interchange of communications modes on battlefield platforms. *FY 2015 Plans:* Design and mature a smart switching system for distributed antenna arrays enabling higher output power, interoperability and improved link connectivity for SATCOM; investigate and mature antenna systems and arrays that provide improved communications performance and reliability through EW jammed environments; develop and finalize 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:* Will 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.			
Title: Tactical Information Assurance (IA) and Cyber Defense (formerly named Wireless IA) *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 compliments this effort, and is fully coordinated with the Army Research Lab Cyber Security Collaborative Research Alliance, PE 0601104A/ project EA6. *FY 2014 Accomplishments:* Designed and coded sophisticated software assurance algorithms to differentiate between stealthy life cycle attacks and software coding errors; designed and assessed secure coding methodologies that can detect and self correct against malicious code insertion; investigated theoretical control graph techniques for improvements in malware detection that can detect malware	9.244	9.321	8.654

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602782A *I Command, Control, Communications Technology*	**Project (Number/Name)** H92 *I Communications Technology*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
variants incorporating polymorphic and metamorphic transformation engines; researched and designed sophisticated, optimized cyber maneuver capabilities that incorporate the use of reasoning, intuition, and perception while determining the optimal scenario on when to maneuver, as well as the ability to map and manage the network to determine probable attack paths and the likelihood of exploit; investigated dynamically and efficiently altering tactical network services, ports, protocols and systems to inhibit red force ability to perform malicious network reconnaissance to determine location of critical networking services; researched and assessed data sharing and collaboration techniques between offensive and defensive operations to enable advanced warning and response actions. *FY 2015 Plans:* Evaluate and mature 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; encode, evaluate and mature software to provide a feedback system to optimize the effectiveness of cyber maneuver and threat assessments; research algorithms and evaluate 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; mature and optimize data sharing and collaboration techniques between offensive and defensive operations and across security boundaries to enable advanced warning and response actions; research trans-disciplinary computer experimentation models that emulate attackers-defenders-users interactions and associated technological and human interrelationships; research 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:* Will 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			

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015	
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602782A *I Command, Control, Communications Technology*	**Project (Number/Name)** H92 *I Communications Technology*	

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
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.			
Title: Cognitive Networking **Description:** This effort investigates, codes, fabricates and evaluates a set of advanced networking devices, software and algorithms to enable wireless networks to sense the dynamic and uncertain nature of mobile ad-hoc multi-tiered, multi-band network environments and spectrum conditions, and automatically adapts network topologies or traffic flows to increase overall performance while reducing the time and human effort required to operate the network. Work being accomplished under PE 0601104A/project H50 and PE 0603008A/project TR1 compliments this effort **FY 2014 Accomplishments:** Researched software for self initiating and managing tactical wireless networks that supports spectrum efficiency in austere tactical environments; researched ad-hoc routing, digital voice and disruption tolerant networking to deliver two way voice, data and position-location information to small units.	0.857	-	-
Title: Future Communications and Networking Technologies (formerly named Dynamic Spectrum and Network 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 compliments this effort. **FY 2014 Accomplishments:** Researched and developed software and hardware techniques allowing electronic warfare (EW) and communications systems to interoperate without mutual interference; researched components, software and algorithms that support a waveform capable of simultaneous automated jamming and communication; investigated coordinated resource allocation, dynamic spectrum access (DSA) and interference cancellation algorithms to support interoperability between different wireless communication networks; investigated spectrum compatibility techniques to enable detection, identification, exploitation, location, disruption and neutralization of adversary RF systems in dense co-channel and multi-path interference environments, while allowing friendly communications and other RF systems to operate effectively in the same spectrum space. **FY 2015 Plans:**	3.350	5.857	8.914

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Investigate techniques for managing and self-initiating wireless networks to improve robustness, efficiency and capacity; investigating coordinated scheduling algorithms and efficient architectures, routing protocols etc. and incorporating 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; research 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; design and code 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; develop a waveform architecture to define interfaces between the various RF, networking and signal processing hardware components; evaluate and develop signal analysis algorithms to detect RF interference of SATCOM signals; research and perform system analysis for protected SATCOM architectures to support modulation, coding and redundancy protection methods; research and analyze precision polarization concepts to support multiple communications paths and bandwidth expansion; perform modeling, simulation and emulation of networks to assess performance in contested environments; mature and evaluate 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:* Will 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			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army | **Date:** February 2015

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System denied environment; develop security framework by investigating multi layer security routing and conduct high assurance internet protocol encryptor bypass study.

Accomplishments/Planned Programs Subtotals	20.078	19.126	20.355

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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| Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army | | | | | | | | | | Date: February 2015 | |

Appropriation/Budget Activity	R-1 Program Element (Number/Name)
2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	PE 0602783A *I Computer and Software Technology*

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
Total Program Element	-	10.232	10.761	12.656	-	12.656	13.811	14.007	14.136	14.415	-	-
Y10: *Computer/Info Sci Tech*	-	10.232	10.761	12.656	-	12.656	13.811	14.007	14.136	14.415	-	-

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 U.S. Army Research Laboratory (ARL) at the Adelphi and Aberdeen Proving Ground, MD locations.

B. Program Change Summary ($ in Millions)

	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Previous President's Budget	10.434	10.764	12.742	-	12.742
Current President's Budget	10.232	10.761	12.656	-	12.656
Total Adjustments	-0.202	-0.003	-0.086	-	-0.086
• Congressional General Reductions	-	-0.003			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.202	-			
• Adjustments to Budget Years	-	-	-0.086	-	-0.086

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army										Date: February 2015	
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602783A *I Computer and Software Technology*						**Project (Number/Name)** Y10 *I Computer/Info Sci Tech*	

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
Y10: *Computer/Info Sci Tech*	-	10.232	10.761	12.656	-	12.656	13.811	14.007	14.136	14.415	-	-

Note
Not applicable for this item.

A. Mission Description and Budget Item Justification
This project develops and evaluates information and communications processing software to automate the delivery of information for planning, rehearsal, and execution by ground commanders. Efforts develop communication/network architectures and software and the information fusion software necessary to simplify the understanding and interactions from humans to humans, humans to computers, computers to humans. Research enables enhanced understanding of many information sources and accelerates the decision cycle time for commanders and leaders operating in mobile, dispersed, highly networked environment envisioned for the future force.

Work in this project is fully coordinated with PE 0603008A (Command, Control, Communications Advanced Technology)and 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 U.S. Army Research Laboratory (ARL), Adelphi and Aberdeen Proving Ground, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Information Processing	1.213	1.248	1.696
Description: This effort develops and evaluates fusion software to improve the completeness and timeliness of decision-making in command and control (C2) operations. 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 2014 Accomplishments:*			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602783A *I Computer and Software Technology*	**Project (Number/Name)** Y10 *I Computer/Info Sci Tech*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Extracted,resolved, and exploited social network information from multi-source data in order to provide timely accurate assessments of social and cultural influences for small unit decision making. *FY 2015 Plans:* Evaluate techniques for predicting crowd attitudes, intent, and behaviors from fused text sources; and develop concepts for integrating social network analysis into the C2. *FY 2016 Plans:* Will examine text analytics techniques for rapid extraction of social and cultural relationship information in order to increase the accuracy and timeliness of predicting attitudes for use in social network analyses; and evaluate the use of crowd sourcing and teaming concepts for analysis in a DCGS-A-like environment.			
Title: Information Assurance *Description:* This effort designs and evaluates 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 the bandwidth constrained tactical networks. *FY 2014 Accomplishments:* Evaluated experimental implementation of intrusion detection software algorithms and architectures; and developed and analyzed predictive models for distributed intrusion detection of cyber attacks in bandwidth constrained environments to improve ability to detect and defeat malicious activities on Army networks and hosts. *FY 2015 Plans:* Design and evaluate 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; investigate models that will be used to develop and evaluate secure protocols that may be used in tactical networks; and explore active protection approaches that may be managed and/or deployed locally, centrally, or in a distributed environment. *FY 2016 Plans:* Will 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.	1.156	2.207	3.562
Title: Information Exchange	1.239	1.280	1.270

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602783A *I Computer and Software Technology*	**Project (Number/Name)** Y10 *I Computer/Info Sci Tech*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Description: This effort will investigate and develop software that integrates sensor data from local and external information sources. The goal is to enable tactical users to cooperatively share relevant and timely tactical information within a distributed wireless environment. *FY 2014 Accomplishments:* Developed workflow and algorithms to enable end-user's ability to define and refine the collection, correlation, and aggregation of raw and processed data from both local and higher echelon information sources to produce summaries that are directly relevant to the user's current operations. *FY 2015 Plans:* Develop and evaluate 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:* Will 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.			
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 2014 Accomplishments:* Developed an experimental framework for evaluation of state-of the-art academic Optical Character Recognition and Machine Translation (OCR/MT), entity extraction, and entity resolution algorithms using realistic, representative data; developed, refined, and tested advanced algorithms to improve multilingual and machine translation technologies in three areas: (a) OCR of noisy and degraded document images typical of field-captured materials, (b) domain-specific machine translation targeting domains and genres outside of commercial interest, and (c) recognition of key content in handwritten documents typical of materials commonly encountered in the field to facilitate the rapid transition of promising candidate technologies. *FY 2015 Plans:* Develop, refine, and test advanced algorithms to improve machine translation technologies by incorporating data subset selection techniques into algorithms to generalize existing MT modules to new domains of military interest. *FY 2016 Plans:*	2.093	2.139	2.053

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602783A *I Computer and Software Technology*	**Project (Number/Name)** Y10 *I Computer/Info Sci Tech*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Will implement and validate advanced algorithms that improve machine translation technologies by incorporating data selection techniques into algorithms to generalize existing MT modules ; and increase ability to translate low density languages of military interest to include key languages native to Africa.			
Title: Network Theory *Description:* This effort investigates and designs theory based software models to evaluate 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 2014 Accomplishments:* Investigated and evaluated techniques for improving network performance and Soldier decision making by adapting data processing and delivery behaviors based on current network abilities and user information quality preferences; developed and evaluated non-traditional communications techniques, such as optical and ultra violet (UV), to provide alternative means of communications in radio frequency (RF)-challenged environments; and investigated techniques for using mobile infrastructure and user movement to improve communication networks and information delivery in hybrid (wired and wireless) networks. *FY 2015 Plans:* Develop and evaluate UV communications components that attach to the RF common sensor radio; use simulation to investigate how mobility and autonomy may be exploited to maintain connectivity; and investigate mapping connectivity regions to blend with mobility planning and sensing. *FY 2016 Plans:* Will 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.	1.849	1.158	1.400
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 2014 Accomplishments:* Developed, implemented and validated discrete mathematical algorithms for high fidelity electromagnetic propagation and electromagnetic interference for use in real time modeling and optimization of ad hoc mobile networks; tested, analyzed, and	1.658	1.673	1.673

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602783A *I Computer and Software Technology*	**Project (Number/Name)** Y10 *I Computer/Info Sci Tech*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
optimized the performance of current and proposed mobile ad hoc network simulations; developed code enabling algorithm deployment for extremely large networks using inter-core load balancing between standard computing cores and specialized accelerators such as Graphics Processing Units; and performed validation of the models and results using standard battle command benchmarks. *FY 2015 Plans:* Investigate approaches for computational off-loading to disparate, hybrid cores focused on extracting maximum performance from the parallel nature of many-core pervasive technologies; create new models to describe offered load and computational capacity within cloudlet-based services in Army-centric mobile and ad hoc networked technologies; and develop software engineering protocols and methods to promote portability while maintaining efficiency with heterogeneous systems. *FY 2016 Plans:* Will develop 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; design the problem for heterogeneous networks and quantify minimum communications path lengths (using quantum annealing algorithms) to converge on a solution for optimum distribution.			
Title: Material Modeling-Force Protection *Description:* This effort designs and evaluates 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 2014 Accomplishments:* Developed parallel computational common software environment on emerging multi-core petaflop high performance computing (HPC) systems; and implemented interface algorithm, data models and formats to solve multi-scale/multi-physics software developed for coupling between molecular dynamics and finite element methods. *FY 2015 Plans:* Develop and extend capabilities to couple multi-scale/multi-physics software that will be designed to achieve efficiency across a growing base of computing cores; and investigate the use of domain specific languages to couple novel HPC capabilities within the material modeling domain and facilitate rapid software deployment. *FY 2016 Plans:* Will 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	1.024	1.056	1.002

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
HPC computing platforms; and investigate applicability of emerging programming languages for specific class of multi-physics applications related to underbody blast applications which includes modeling of the Soldier.			
Accomplishments/Planned Programs Subtotals	10.232	10.761	12.656

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army										Date: February 2015	

Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I BA 2: Applied Research*					R-1 Program Element (Number/Name) PE 0602784A *I Military Engineering Technology*						

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
Total Program Element	-	69.192	67.302	63.409	-	63.409	67.350	70.520	75.422	76.878	-	-
855: *Topographical, Image Intel & Space*	-	17.530	15.476	16.116	-	16.116	17.555	18.367	18.498	18.859	-	-
H71: *Meteorological Research For Battle Command*	-	6.349	6.459	6.455	-	6.455	6.476	6.590	6.632	6.762	-	-
T40: *Mob/Wpns Eff Tech*	-	30.743	27.102	26.514	-	26.514	28.142	29.830	34.462	35.139	-	-
T41: *Mil Facilities Eng Tec*	-	6.251	5.641	5.845	-	5.845	6.216	6.437	6.477	6.593	-	-
T42: *Terrestrial Science Applied Research*	-	5.106	5.203	5.158	-	5.158	5.152	5.343	5.377	5.482	-	-
T45: *Energy Tec Apl Mil Fac*	-	3.213	3.421	3.321	-	3.321	3.809	3.953	3.976	4.043	-	-
T53: *Military Engineering Applied Research (CA)*	-	-	4.000	-	-	-	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

This program element (PE) investigates, evaluates, and advances technologies, techniques and tools for depiction and 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; 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 (includes Deployable Force Protection). 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 and evaluates 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.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army	Date: February 2015
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602784A I *Military Engineering Technology*

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 U.S. Army Engineer Research and Development Center, Vicksburg, MS, and the Army Research Laboratory, Aberdeen Proving Ground, MD. Deployable force protection activities are coordinated with research, development and engineering centers and laboratories across the US Army, Navy and Air Force.

B. Program Change Summary ($ in Millions)	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total
Previous President's Budget	70.027	63.311	62.757	-	62.757
Current President's Budget	69.192	67.302	63.409	-	63.409
Total Adjustments	-0.835	3.991	0.652	-	0.652
• Congressional General Reductions	-	-0.009			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	4.000			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-0.835	-	0.652	-	0.652

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2014	FY 2015
Project: T53: *Military Engineering Applied Research (CA)*		
Congressional Add: *Program Increase*	-	4.000
Congressional Add Subtotals for Project: T53	-	4.000
Congressional Add Totals for all Projects	-	4.000

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army										**Date:** February 2015	
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602784A *I Military Engineering Technology*					**Project (Number/Name)** 855 *I Topographical, Image Intel & Space*		

COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
855: *Topographical, Image Intel & Space*	-	17.530	15.476	16.116	-	16.116	17.555	18.367	18.498	18.859	-	-

Note
Not applicable for this item

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; for digital map creation, transmission, and dissemination; and for 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's 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 S&T Command, Control, Communications and Intelligence (C3I) Portfolio.

Work in this project complements efforts in 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 U.S. Army Engineer Research and Development Center, Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Title: Terrain Analysis for Signal and Sensor Phenomenology	3.704	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;			

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Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602784A *I Military Engineering Technology*	**Project (Number/Name)** 855 *I Topographical, Image Intel & Space*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
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. *FY 2014 Accomplishments:* Investigated LiDAR detectable, engineered optical materials to perform adversary tagging, physical location, disturbance, and tracking for area and point operations; investigated uncertainties associated with bio-affected sensors and sensing modalities (i.e., time-varying, and terrain-varying conditions) to enhance capabilities for target of interest identification in high clutter environments; developed geospatial display layers for digital maps that depict sensor performance and associated sensor uncertainties. Conducted research and experiments to develop standoff detection and early warning capability of threats to critical infrastructure in extreme environments using innovative fiber optic sensing technology. *FY 2015 Plans:* Develop 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:* Will develop initial algorithms to exploit 3D terrain data using hyper-spectral data sources; Will 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. *FY 2014 Accomplishments:* Continued development of remote sensing capabilities to support multi-agency efforts in remote illicit crop monitoring; developed and integrated cultural mapping into military geospatial narratives; developed visualization and analysis tools for user generated content and volunteered geographic information to support ongoing collaboration with partners. *FY 2015 Plans:* Develop 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 will add novel context to conventional quantitative data sources	3.563	2.438	4.970

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
and information, thereby providing increased awareness and surveillance of both the human and physical dimensions. Develop automated workflows to provision high-resolution imagery and geodata to mobile, dismounted devices for mission command platforms in mounted and mobile computing environments. Develop 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:* Will investigate and develop geospatial analysis tools leveraging authoritative DoD databases to support military planning; Will develop methods to efficiently query databases in multiple Computing Environments to produce geospatial overlays depicting elements of sociocultural behavior; Will research methods allowing Army planners to exploit the Standard, Shareable, Geospatial Foundation (SSGF) data and services to provide a common geospatial framework for commanders and their staff.			
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. *FY 2014 Accomplishments:* Designed and developed the framework for a common scalable architecture to deploy geospatial, geo-environmental, and social-cultural data, in the form of analytics and tools, through the Army Geospatial Enterprise. Developed geospatial operational risk zone analytics based on insurgent activity, terrain attributes, mission, and environmental influences; incorporated real-time feedback on integrated sensor performance and effectiveness for enhanced mission planning. *FY 2015 Plans:* Develop methods for super-resolution data processing (i.e., imagery, Light Detection and Ranging, Hyperspectral, multispectral), and algorithms to exploit this data. This research will be specific to challenges faced by small units in urban environments that can be addressed through high-fidelity geospatial data. Will initiate 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:* Will begin development on methods to deliver and integrate novel geospatial products using open standards and formats into the Army Geospatial Enterprise (AGE); Will begin research on information fusion to evaluate accuracy and relevance of dynamic terrain information layers that support the military decision making process; Will initiate methods to leverage and develop open source Light Detection and Ranging (LIDAR) processing capabilities to enhance feature classification and sensor exploitation. Will begin development of stand-off soil moisture assessments and comparisons to further assist real-time mapping of moisture levels,	4.703	5.958	6.082

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
assisting in mobility forecasts. Will begin research on information fusion to evaluate accuracy and relevance of dynamic terrain information layers that support the military decision making process.			
Title: Geospatial and Temporal Information Structure and Framework	5.560	4.472	2.816
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. *FY 2014 Accomplishments:* Conducted research to integrate geo-environmental and socio-cultural information at the tactical edge; generated geospatial information that defines aggregate constructs of spatial and structural data key to Civil Military Operations (CMO); identified and built relational networks to define the interactive complexity between geospatial structures and actor/event and outcome dynamics. Initiated design for a data and query model, and system architecture capable of ingesting, processing, storing, and searching high volume and velocity multi-modal, multi-scale geospatial data. *FY 2015 Plans:* Develop 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. Investigate 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:* Will 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; Will explore new exploitation techniques and algorithms to characterize the urban operational environment and develop geospatial products focused on hazardous terrain identification; Will enhance the capability to capture and visualize dynamic spatio-temporal narratives that describe relationships of people, events, and geographic locations through time; Will develop the capability to characterize the relationship between environment and conflict through systems models that demonstrate the impacts of environmental conditions on stability. Will develop algorithms to incorporate sociocultural factors and data for more effective analysis of violent events.			
Accomplishments/Planned Programs Subtotals	17.530	15.476	16.116

C. Other Program Funding Summary ($ in Millions)

N/A

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
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C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army										Date: February 2015	
Appropriation/Budget Activity 2040 I 2				**R-1 Program Element (Number/Name)** PE 0602784A I *Military Engineering Technology*						**Project (Number/Name)** H71 I *Meteorological Research For Battle Command*	

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
H71: *Meteorological Research For Battle Command*	-	6.349	6.459	6.455	-	6.455	6.476	6.590	6.632	6.762	-	-

Note
Not applicable for this item.

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 S&T 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 Weather Agency to improve their operational weather support to the Army PM-MaTIC (PM-Meteorological and Target Identification Capabilities) 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, and Tactical Airspace Integration System (TIAS).

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Atmospheric Modeling *Description:* This effort develops high resolution, short-range forecasting, and high resolution atmospheric modeling capabilities for mountainous, urban, and forest complex terrain.	2.526	2.579	2.558

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
FY 2014 Accomplishments: Investigated and verified the Atmospheric Boundary Layer Environment (ABLE) model that incorporates microscale wind, temperature, and moisture dynamics for more realistic and accurate prediction of turbulence, jets, convective eddies and gusts; investigate and verify the sub-kilometer Weather Running Estimate-Nowcast (WRE-N) (with tailored four-dimensional data assimilation) for complex terrain and implemented version to supply data for actionable weather impact decision aids; and evaluated modeling post-processing methods for enhancement of meteorological accuracy for artillery applications. *FY 2015 Plans:* Develop microscale (local) weather prediction model (ABLE) and mature the capability to implement this model in the mesoscale WRE-N model to provide and increase the reliability of microscale (local) weather forecasts; develop 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 implement ABLE model capability for artillery target area domains. *FY 2016 Plans:* Will 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 (FDDA) 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.			
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 2014 Accomplishments:* Investigated and evaluated electromagnetic, intelligent optical and acoustic remote sensing techniques and sensor performance models for the detection of adverse environmental conditions, individual targets and local and regional events to support Army Operations and Military Intelligence; developed anomaly image quality metrics for detecting areas of interest within optical images; investigated and evaluated a prototype dynamic passive optics aperture system for its ability to reduce short exposure turbulence	1.935	1.964	1.972

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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
blur as it captures images; and investigated mobile handheld technology applications that determine atmospheric impacts on Soldiers and autonomous systems to enhance mission effectiveness at the lowest echelons. *FY 2015 Plans:* Develop 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; determine the performance effectiveness of dual-band (midwave infrared (MWIR) and long wavelength IR (LWIR)) thermal polarimetric imagers to discriminate camouflage under varying environmental conditions; conduct experiments to determine vulnerabilities of various camouflage materials when simultaneously exposed to dual-band thermal polarimetry; develop elevation and location correction algorithms to more accurately detect and track Unmanned Aircraft Systems (UASs) by acoustic arrays; and develop elevation correction due to atmospheric propagation for UAS tracking by acoustic arrays. *FY 2016 Plans:* Will design and develop MSA components that provide, non-standard sensing capabilities for the atmospheric boundary layer; and 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: Atmospheric Prediction for Local Areas *Description:* This effort designs and evaluates software models and sensors to improve local characterization and prediction of atmospheric conditions in urban and complex terrain by directly integrating boundary layer meteorological (MET) measurements into high resolution models and decision aids and verifies these improvements with field measurements. *FY 2014 Accomplishments:* Investigated techniques for integrating forecast grids into weather impacts decision support tools (DSTs); and researched, developed, and verified impact enhancements to DSTs to improve the characterization of local atmospheric impacts and support source identification of aerosol particles. *FY 2015 Plans:* Research tactical network capabilities to identify the most efficient methods to transmit/receive weather data for mobile weather decision aid applications; mature techniques and algorithms for integrating forecast grids into weather DSTs and implement initial capabilities in those systems; continue 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; develop a DST to exploit anomaly image quality metrics for detecting areas of interest within optical images; and research how weather affects human behavior and begin development of a threat personnel	1.888	1.916	1.925

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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
biometeorological impacts and insurgent/terrorist activities prediction system. This system will correlate existing or predicted weather conditions with possible insurgent/terrorist activities, such as improvised explosive device (IED) emplacement. *FY 2016 Plans:* Will prepare the ABLE microscale model for transition into the Distributed Common Ground Station-Army (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 WRE-N now-casting model results (rapidly updated local short-term predictions) will be integrated with weather decision support tools for mission planning and execution.			
Accomplishments/Planned Programs Subtotals	6.349	6.459	6.455

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army											**Date:** February 2015	
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COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
T40: *Mob/Wpns Eff Tech*	-	30.743	27.102	26.514	-	26.514	28.142	29.830	34.462	35.139	-	-

Note
Not applicable for this item

A. Mission Description and Budget Item Justification
This project investigates, evaluates, and creates technologies for adaptive and expedient force protection across the range of military operations; for force projection and maneuver, including austere port entry and overcoming battlespace gaps (such as cliffs, ravines, mudflats, shallow rivers, and other natural obstacles) through prediction, definition, avoidance, or defeat of the gaps; for scalable weapons effects; and for high-resolution representation of near-surface terrain and environment for use with sensor models for things such as 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 weapons attacks and enables maneuver support of deployed forces, while reducing their logistical footprint. This project supports Deployable force protection (DFP) efforts for overcoming critical capability gaps for protecting troops operating at smaller bases that are remote or integrated in with local communities.

Work in this project supports the Army S&T 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 US Army Engineer Research and Development Center, Vicksburg, MS. Deployable force protection activities are coordinated with research, development and engineering centers and laboratories across the US Army, Navy and Air Force.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Title: Adaptive Protection	7.546	10.559	10.521
Description: This effort develops new analytical techniques, advanced materials, and integrated protection systems to support the protection of critical assets on the battlefield.			
FY 2014 Accomplishments: Developed capability to plan and construct a protected Combat Outpost (COP) or Patrol Base (PB) in 30 days with integrated protective construction, sensing and active defense capabilities; developed a baseline COP construction handbook and decision support tools for planning of overall basing architecture that integrates force protection and basing functions; developed planning			

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army			Date: February 2015
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
tools for the complete lifecycle of the COP; completed development of modeling and simulation capabilities for comprehensive mine and improvised explosive device (IED) blast loads for vehicle occupant threats. *FY 2015 Plans:* Develop technologies to determine vulnerability of critical facilities and assess degradation to operational capability; develop protective measures that use indigenous materials and on-site production capability; provide integrated protection planning tools that include pre-deployment, construction, operations, and relocation. *FY 2016 Plans:* Will develop rapidly emplaced force protection technologies and survivability and planning tools that will lead to decreased required Soldiers needed for construction of COP/PB. Will develop force protection technologies to mitigate lethality of advanced threats in order to increase survivability of personnel, critical assets, and fixed facilities. Will develop/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.			
Title: Austere Entry and Maneuver *Description:* This effort investigates, designs, and creates tools and technologies that address theater access, tactical logistics resupply, and tactical maneuver of small units. *FY 2014 Accomplishments:* Developed the capability to numerically simulate complex, impulsive, fixed and moving infrasound, which are very low frequency sound waves, sources for regional assessment of strategic infrastructure and assets; created a high-performance computational testbed (CTB) for dismounted operations including simulations of potential offloading platforms as well as soldiers in the 9-man squad; provided a rapid remote port assessment capability for improving Force Projection in expeditionary environments; provided improved bridging materiel solutions for spanning gaps (wet or dry) that can impede critical operations; developed advanced force projection technologies for landing zones and port construction in areas of Anti-Access/Area Denied. *FY 2015 Plans:* Develop 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. Develop simulation capability to enable rapid remote assessment of real-time structural capacity of infrastructure (airfields, ports, roads), river, estuary, and near shore. *FY 2016 Plans:* Will develop computational testbed applications to simulate the influence of dynamic environmental effects created by vehicles and humans on sensor-based perception. Will complete modeling of dismounted operations and continue to develop the	11.269	13.900	12.760

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
distribution management tool and provide systems integration to simulate the entire logistics distribution network. Will complete development of the capability to numerically simulate infrasonic sources for regional assessment of infrastructures. Will refine radar evaluation of airports/seaports of debarkation and reduced order modeling for austere entry assessment.			
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 such things as 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, designs, and fabricates non-line-of-sight and beyond- line-of-sight sensing in remote areas, including optimizing coupling of sensors to soil for understanding surface and subsurface activities. This effort supports persistent surveillance and detection capabilities. **FY 2014 Accomplishments:** Provided system performance optimization of linear sensors for austere deployment environments; developed a sensor model response for tracking of human and vehicular stimuli with 3-dimensional seismic source models; developed high fidelity excitation models of these linear sensors; quantified coupling scenarios for unique geo-environments. **FY 2015 Plans:** Validate three-dimensional source models of human and vehicular traffic in complex environments to determine transduction mechanisms of linear sensors; and develop physics-based model of linear sensor excitation by high-fidelity viscoelastic and discrete element methods. **FY 2016 Plans:** Will 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.	1.923	1.479	2.000
Title: Deployable Force Protection **Description:** This effort researches, designs, and creates rapidly deployable detection, assessment, passive protection and active defensive technology-enabled capabilities to meet critical capability gaps for troops operating remotely at smaller bases or integrated with local communities. The needs at these smaller bases (less than 300 persons, not all U.S. troops) are unique based on constraints in transportability, manpower, organic resources, lack of hardening of structures, resupply, and training for example. Moreover, lack of interoperability and scalability consume manpower and take away from time needed to perform missions. Threats include bases being overrun by hostiles; direct fire; rockets, artillery and mortars; and improvised explosive	8.900	-	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
devices. Force protection challenges at these remote, smaller bases include providing increased standoff detection, blast and ballistic protection, and kinetic technologies subject to the constraints mentioned above. This work is coordinated with PE 0603784A/T08, PE 0603125A/DF5, PE 0603313A/G03 and PE 0602786A. Work is performed by Army, Navy and Air Force labs and centers. *FY 2014 Accomplishments:* Completed research and development on selected materials and system designs for rapidly erectable or constructed personnel protective systems to decrease logistics (e.g., weight, set up time), increase transportability, and increase protection levels for the next-generation systems; developed non-lethal stand-off enforcement technologies and conducted analysis to assess suitability for employment at small base entry control points; developed second-generation, low-logistics structural components for exterior and interior protection of indigenous structures; research and development on promising technologies and systems approaches that detect, assess, and accurately locate threats in non-line-of sight and complex environments and will decrease size, weight, and power requirements. User assessment and feedback gathered from deployable force protection experiments were used to improve technical performance, logistics, and user factors associated with deployable force protection for the activities described above.			
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 2014 Accomplishments:* Created a first version of a computational testbed to simulate materials at the nanometer scale using a combination of the Discrete Element Method coupled with continuum analyses. *FY 2015 Plans:* Develop and enhance the fidelity and efficiency of multi-scale predictive design tools to incorporate materials by design principles for development of enhanced protective structures; develop and integrate novel multiscale reinforced cementitious materials and components of protective structures; develop 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:* Will enhance materials by design of cementitious and polymer composite protective materials through the continued development and validation of multi-scale predictive design tools; will develop methods to control bonds between reinforcement and	1.105	1.164	1.233

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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
cementitious matrices at multiple scales to optimize composite performance; will integrate novel processing and additive manufacturing methodologies into material system design and fabrication methods to support the maturation of advanced protective solutions.			
Accomplishments/Planned Programs Subtotals	30.743	27.102	26.514

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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R-1 Program Element (Number/Name)
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Project (Number/Name)
T41 / *Mil Facilities Eng Tec*

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
T41: *Mil Facilities Eng Tec*	-	6.251	5.641	5.845	-	5.845	6.216	6.437	6.477	6.593	-	-

Note
Not applicable for this item

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 S&T 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 US Army Engineer Research and Development Center, Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Adaptive and Resilient Installations	3.357	3.094	3.122
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 2014 Accomplishments:			

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602784A *I Military Engineering Technology*	**Project (Number/Name)** T41 *I Mil Facilities Eng Tec*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Developed and integrated sustainment, restoration and modernization decision models to support planning and analysis of high performance buildings; developed and validated adaptive system algorithms and relationships, and models for power, water, waste and protection to reflect the dynamics at forward operating bases. *FY 2015 Plans:* Complete 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; Complete integrated modeling capability building on the Net Zero Energy Framework to support Installation planning for energy, water, and waste resource optimization. *FY 2016 Plans:* Will research the necessary mixture design and admixtures requisite to allow additive construction using cementitious materials across the broadest possible locations and operating environments. Will include determining the correct formulations to adapt locally available cementitious materials to required rheology, curing time, and strength for automated additive construction of expeditionary structures. Will also determine the serviceability of other native material (such as soils, clay sand mixtures like adobe) for use as extrudable building materials.			
Title: Social/Cultural Behavior *Description:* 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. *FY 2014 Accomplishments:* Developed analytical models that advise the commander on likely socio-cultural consequences of planned military courses of action impacting indigenous population; provided the commander a computer aided methodology to identify insights into socio-cultural issues, needs, and likely perceptions to planned unit actions and tasks in the commander's area of responsibility. *FY 2015 Plans:* Investigate the unique capability to characterize sub-national populations, environmental degradation, and risks to security in complex operational environments based on accessible pre-conflict data; Investigate monitoring tools and decision models reflecting effects of changing conditions on the operating environment for Brigade-level operators and mission planners; identify 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:*	2.894	2.547	2.723

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602784A *I Military Engineering Technology*	**Project (Number/Name)** T41 *I Mil Facilities Eng Tec*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Will investigate capability to integrate existing information about population and knowledge of the theater environment to monitor urban conditions and drive assessment of strengths and deficiencies of host-nation areas; will develop methods to produce composite geospatial products from multiple human and environmental data inputs and semi-automated analytic tools; will investigate approaches to represent indictors in spatial-temporal views for the Warfighter to incorporate into Military Decision Making Process (MDMP) and Troop Leading Procedures (TLP) products.			
Accomplishments/Planned Programs Subtotals	6.251	5.641	5.845

C. Other Program Funding Summary ($ in Millions)

 N/A

Remarks

D. Acquisition Strategy

 N/A

E. Performance Metrics

 N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army											Date: February 2015	
Appropriation/Budget Activity 2040 *I* 2						**R-1 Program Element (Number/Name)** PE 0602784A *I Military Engineering Technology*					**Project (Number/Name)** T42 *I Terrestrial Science Applied Research*	

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
T42: *Terrestrial Science Applied Research*	-	5.106	5.203	5.158	-	5.158	5.152	5.343	5.377	5.482	-	-

Note
 Not applicable for this item

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 S&T 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 US Army Engineer Research and Development Center, Vicksburg, MS.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Analysis for Signal & Signature Phenomenology	2.397	2.755	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. *FY 2014 Accomplishments:* Developed and integrated into the sensor mission planning tool Environmental Awareness for Sensor and Emitter Employment (EASEE) terrain and weather influences and model predictions for radar and radio frequency modalities; developed and integrated functionality for providing multi-modal propagation predictions for multiple moving platforms; developed an automated remote sensing capability to provide tactical commanders a repeatable assessment of mountainous snowpack extent and snowpack total water storage to inform mission planning decision making social-cultural mission impacts. *FY 2015 Plans:* Research and develop 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			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 *I* 2	R-1 Program Element (Number/Name) PE 0602784A *I Military Engineering Technology*	Project (Number/Name) T42 *I Terrestrial Science Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
(soils, vegetation, landscape, structures), weather influences (rapid dynamic changes), and information collection modalities (seismic, acoustic, radio frequency, electro-optical propagation); investigate 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:* Will 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; will develop techniques for fusing disparate data sources and types (e.g. point clouds and imagery) by retaining all critical collection attributes, thus providing significant military utility of terrain information and features for high fidelity mission planning and execution.			
Title: Geospatial Reasoning *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 2014 Accomplishments:* Developed decision support tool for combat outpost applications optimizing human and physical terrain surveillance by matching sensor modalities to mission, terrain complexity, and predicted weather effects; investigated and developed components of a sensor coverage and management framework for integrating ground and air surveillance assets based upon site specific terrain and weather conditions; investigated sensor modalities and developed software to perform rapid, stand-off assessments of austere entry locations by remotely assessing terrain condition (soil physical properties) and integrating weather effects. *FY 2015 Plans:* Research and establish 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:* Will 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. Will initiate evaluation of acoustic, seismic and radiofrequency (RF) modeling complexities in complex urban and terrain environments where signals are impacted by scattering objects. Will conduct research of time-sensitive activity within the soil as shaped by dynamic soil descriptors to support	2.709	2.448	2.436

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602784A *I Military Engineering Technology*	**Project (Number/Name)** T42 *I Terrestrial Science Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
enhanced predictive analysis of soil-weather-terrain governed maneuver and sensor constraints. Will investigate remote and automated analysis methods for identifying and locating areas suitable for aircraft landing or drop zones.			
Accomplishments/Planned Programs Subtotals	5.106	5.203	5.158

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army										Date: February 2015	
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602784A *I Military Engineering Technology*						**Project (Number/Name)** T45 *I Energy Tec Apl Mil Fac*	

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
T45: *Energy Tec Apl Mil Fac*	-	3.213	3.421	3.321	-	3.321	3.809	3.953	3.976	4.043	-	-

Note
 Not applicable for this item

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, training, and in the theater of operations to reduce logistical footprint. This effort provides 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 provide 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 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.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Adaptive and Resilient Installations	3.213	3.421	3.321
Description: This effort investigates and develops technologies necessary for energy efficiency and sustainable military installations, emphasizing energy and utility systems. **FY 2014 Accomplishments:** Developed and began the integration of sustainment, restoration and modernization decision models that maximize effectiveness of facility retrofits, specifically for energy performance; validated multi-dimensional models and algorithms using emerging building envelope materials to reduce energy losses and transition innovative concepts for application of advanced technology to meet mandated energy reduction goals. **FY 2015 Plans:**			

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602784A *I Military Engineering Technology*	**Project (Number/Name)** T45 *I Energy Tec Apl Mil Fac*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Develop 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. Investigate use of indigenous materials for forward operating bases and contingency bases; investigate smart and multifunctional materials and systems that increase strength, durability, resilience and electromagnetic shielding for buildings and hard shelter envelopes. *FY 2016 Plans:* Will investigate the impacts on energy efficiency and lifecycle sustainability of contingency based structures constructed with cementitious materials assembled via an additive process for construction. Will investigate the impacts on construction geometries of the structures along with the physical attributes of the supporting pad and walls as well as the ceiling. Will evaluate material mixtures and additivies, as well as nozzle shapes and combinations, to allow complex wall configurations to improve thermal characteristics while maintaining structural integrity.			
Accomplishments/Planned Programs Subtotals	3.213	3.421	3.321

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army											**Date:** February 2015	
Appropriation/Budget Activity 2040 I 2					**R-1 Program Element (Number/Name)** PE 0602784A I *Military Engineering Technology*					**Project (Number/Name)** T53 I *Military Engineering Applied Research (CA)*		
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
T53: *Military Engineering Applied Research (CA)*	-	-	4.000	-	-	-	-	-	-	-	-	-

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 2014**	**FY 2015**
Congressional Add: Program Increase	-	4.000
FY 2015 Plans: Program increase for military engineering applied research		
Congressional Adds Subtotals	-	4.000

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army											Date: February 2015	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					**R-1 Program Element (Number/Name)** PE 0602785A I *Manpower/Personnel/Training Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
Total Program Element	-	17.395	23.288	24.735	-	24.735	26.045	24.910	25.184	25.679	-	-
790: *Personnel Performance & Training Technology*	-	17.395	23.288	24.735	-	24.735	26.045	24.910	25.184	25.679	-	-

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 US Army Research Institute (ARI) for the Behavioral and Social Sciences in Ft. Belvoir, VA.

B. Program Change Summary ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**
Previous President's Budget	17.645	23.295	24.889	-	24.889
Current President's Budget	17.395	23.288	24.735	-	24.735
Total Adjustments	-0.250	-0.007	-0.154	-	-0.154
• Congressional General Reductions	-	-0.007			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.250	-			
• Adjustments to Budget Years	-	-	-0.154	-	-0.154

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army											**Date:** February 2015	
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602785A *I Manpower/Personnel/ Training Technology*					**Project (Number/Name)** 790 *I Personnel Performance & Training Technology*			
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
790: *Personnel Performance & Training Technology*	-	17.395	23.288	24.735	-	24.735	26.045	24.910	25.184	25.679	-	-

Note
 Not applicable for this item.

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 US Army Research Institute (ARI) for the Behavioral and Social Sciences in Ft. Belvoir, VA.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Title: Personnel ***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 2014 Accomplishments:*** Initiated research on the use of non-cognitive measures to improve the officer classification process; completed multi-year validation of selection efficiency research; determined higher-order skill sets required for enlisted performance assessment across	7.119	8.494	8.296

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602785A *I Manpower/Personnel/* *Training Technology*	**Project (Number/Name)** 790 *I Personnel Performance & Training* *Technology*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
multiple clusters of job types to improve classification process and personnel/job matching; Initiated research on new measures to improve the selection of cyber personnel. *FY 2015 Plans:* Will conduct longitudinal validation of non-cognitive measures for awarding ROTC scholarships to high-potential officer candidates. Will initiate validation of the Information/Communications Technology Literacy Test (ICTL) as a measure to predict performance in cyber-related domains. *FY 2016 Plans:* Will develop and validate new individual difference measures for predicting the job performance of Army strategic planners; will develop a scientifically valid combination of pre-commissioning indices and non-cognitive measures for predicting officer job performance across multiple branches/functional areas; will develop new assessments for predicting performance in cyber-related jobs.			
Title: Personnel Readiness and Performance *Description:* This effort, previously titled "Training," will investigate and develop effective training and leader development methods to assess, enhance, and sustain individual and unit readiness, resilience, and effectiveness. *FY 2014 Accomplishments:* Developed automated assessment tool for trainee performance to enable the Army Learning Model (i.e., accelerating learning and increasing adaptation to changing operational requirements); developed innovative training framework and methods for collective training of units that must perform exceptionally well in complex operational environments. *FY 2015 Plans:* Will develop training methods that expedite training across a range of tasks and training environments. Will initiate training research to improve Non-commissioned Officers' (NCOs) ability to develop junior Soldiers. Will initiate the development of strategies (e.g., training) for small unit leaders to create ready and resilient units. *FY 2016 Plans:* Develop assessment methods and identify pre-cursor factors for unit resilience to enhance unit and Soldier readiness. Will design and develop exemplar measures, methods, and resources to support effective training and leader development for junior non-commissioned officers (NCOs). Will design and develop prototype measures and methods for small-unit leaders to improve Soldier readiness. Will develop job aids for core cognitive and behavioral skills that enhance Soldier readiness.	8.274	6.328	11.863
Title: Army Leadership and Culture	2.002	8.466	4.576

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602785A *I Manpower/Personnel/ Training Technology*	**Project (Number/Name)** 790 *I Personnel Performance & Training Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Description: This effort, previously titled "Leader Development," 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 2014 Accomplishments:* Investigated strategic decision-making of leaders to inform a comprehensive design guide for commanders and staff; investigated knowledge/skill/ability requirements for an operational environment to design a training framework and integrate multiple cross-cultural skills to improve leader performance in cross-cultural situations. *FY 2015 Plans:* Will develop innovative methods and techniques to develop leader skills (e.g., techniques for mentorship, coaching, and subordinate development). Will initiate research to develop innovative training methods for Sexual Harassment/Assault Response and Prevention (SHARP). *FY 2016 Plans:* Will conduct research on empathy-based training methods to prevent and reduce the incidence of sexual harassment and assault; will develop scientifically valid on-the-job resources to enable Army leaders to shape and influence unit climate.			
Accomplishments/Planned Programs Subtotals	17.395	23.288	24.735

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

Remarks

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army											Date: February 2015	

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

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
Total Program Element	-	30.950	32.044	35.795	-	35.795	34.603	34.475	35.567	36.303	-	-
283: *Airdrop Adv Tech*	-	2.363	2.392	3.085	-	3.085	3.432	2.813	2.773	2.827	-	-
E01: *Warfighter Technology Initiatives (CA)*	-	-	6.300	-	-	-	-	-	-	-	-	-
H98: *Clothing & Equipm Tech*	-	21.311	18.985	27.642	-	27.642	23.771	23.407	24.576	25.096	-	-
H99: *Joint Service Combat Feeding Technology*	-	5.751	3.029	3.310	-	3.310	4.919	5.030	5.066	5.164	-	-
VT4: *Expeditionary Mobile Base Camp Technology*	-	1.525	1.338	1.758	-	1.758	2.481	3.225	3.152	3.216	-	-

Note

FY16 funds increased to support the strategic shift from 6.3 to 6.2 human performance efforts as well as material technologies for Soldier Protection.

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, field quality of life and assess 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 (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 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 0602105A (Materials Technology), PE 0602618A (Ballistics Technology), PE 0603001A (Warfighter Advanced Technology), PE 0602787A (Medical Technology Initiatives), PE 0602716A (Human Factors Engineering Technology), and PE 0602784A (Military 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 is led, performed, and/or managed by the Natick Soldier Research, Development, and Engineering Center (NSRDEC), Natick, MA.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army			**Date:** February 2015	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*		**R-1 Program Element (Number/Name)** PE 0602786A *I Warfighter Technology*		

B. Program Change Summary ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**
Previous President's Budget	31.529	25.751	31.241	-	31.241
Current President's Budget	30.950	32.044	35.795	-	35.795
Total Adjustments	-0.579	6.293	4.554	-	4.554
• Congressional General Reductions	-	-0.007			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	6.300			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.579	-			
• Adjustments to Budget Years	-	-	4.554	-	4.554

Congressional Add Details ($ in Millions, and Includes General Reductions)	**FY 2014**	**FY 2015**
Project: E01: *Warfighter Technology Initiatives (CA)*		
Congressional Add: *Program Increase*	-	6.300
Congressional Add Subtotals for Project: E01	-	6.300
Congressional Add Totals for all Projects	-	6.300

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army										Date: February 2015	

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R-1 Program Element (Number/Name)
PE 0602786A *I Warfighter Technology*

Project (Number/Name)
283 *I Airdrop Adv Tech*

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
283: *Airdrop Adv Tech*	-	2.363	2.392	3.085	-	3.085	3.432	2.813	2.773	2.827	-	-

Note
 Not applicable for this item.

A. Mission Description and Budget Item Justification

This project funds research, investigation, and evaluation 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 program element 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 PE 0603001A/Project 242 (Warfighter Advanced Technology).

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Airdrop/Aerial Delivery Research and Technology	2.363	2.392	3.085
Description: This effort provides complementary investigations of technologies for enhanced payload extraction and subsequent gliding capabilities, improves delivery accuracy of varying load weights, and investigates technologies for improved insertion safety and security for airborne personnel.			
FY 2014 Accomplishments: Investigated navigation technologies in GPS denied areas to reduce Soldier borne equipment load by increasing resupply to austere operational environments; building on results from FY13, investigated the application of e-textiles and embedded miniature sensors in parachute systems to improve aerial decelerator performance characteristics, increased operator safety (increased control and glide enhancement), decreased system costs, and reduced load burden for Soldiers engaged in airborne operations by lowering the retrograde/retrieval weight and volume of current equipment. **FY 2015 Plans:**			

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
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 2014**	**FY 2015**	**FY 2016**
Investigate wind detection methods/methodologies for precision guidance, navigation, and control; develop static line reserve parachute automatic activation technologies for future incorporation into personnel parachute systems to increase operator safety; design 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; investigate methods/methodologies for enhancing autonomous glide and precision delivery landing accuracy. *FY 2016 Plans:* Will investigate adaptive flight software to overcome rigging errors and broken control lines of Joint Precision Aerial Delivery System cargo parafoils; utilize modeling and simulation (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.			
Accomplishments/Planned Programs Subtotals	2.363	2.392	3.085

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army											**Date:** February 2015	
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602786A *I Warfighter Technology*					**Project (Number/Name)** E01 *I Warfighter Technology Initiatives (CA)*			
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
E01: *Warfighter Technology Initiatives (CA)*	-	-	6.300	-	-	-	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Warfighter Technology Applied Research.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**
Congressional Add: Program Increase	-	6.300
FY 2015 Plans: Program Increase		
Congressional Adds Subtotals	-	6.300

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 2016 Army										Date: February 2015		
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 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
H98: Clothing & Equipm Tech	-	21.311	18.985	27.642	-	27.642	23.771	23.407	24.576	25.096	-	-

Note
Not applicable for this item.

A. Mission Description and Budget Item Justification
This project investigates and evaluates 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 with a focus on human science investigation to identify and develop methods to assess human responses to sensory, physical, cognitive, and affective stimuli and stressors.

Efforts in this program element support the Army science and technology Soldier/Squad portfolio.

Work in this 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 Natick Soldier Research, Development, and Engineering Center (NSRDEC), Natick, MA.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Soldier Blast and Ballistic Protection **Description:** This effort focuses on material modeling, novel materials, and component designs to protect Soldiers against ballistic and blast threats. This effort utilizes a cross-disciplinary, human-centric approach to develop technologies, which optimize tradeoffs in ballistic and blast protective component design. This effort is fully coordinated with PE 0602787A/Project FH2, Project VB3, Project 874 (Medical Technology), PE 0602618A/H80 (ARL), PE0602105A/Project H84 (ARL), PE0602716A/Project H70 (ARL), and PE 0603001/Project J50. This effort supports Force Protection Soldier & Small Unit capability research and addresses the Army top challenge of easing overburdened Soldiers in small units. **FY 2014 Accomplishments:** Developed and evaluated ballistic and blast component concepts that fully delineate weight, performance, and mobility trade space using modeling and casualty assessment tools as well as ergonomic and ballistic test methods; investigated new ballistic	4.759	4.110	5.909

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
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 2014	FY 2015	FY 2016
fiber and composite material to increase strength and toughness while decreasing component weight; developed relevant criteria and advance concepts for assessing behind armor blunt trauma; investigated and applied advanced techniques for multiscale analysis of factors that affect ballistic performance (yarn deniers, surface treatments, material configuration, fiber properties) to develop predictive model(s) for assessing armor systems; developed methods for assessing environmental stability and durability of high performance fibers and composites that enhance Soldier protection in various operational environments. *FY 2015 Plans:* Develop predictive models for estimation of performance of ballistic fibers after exposure to adverse operational and storage environments; investigate laboratory methods of simulating and measuring forces and accelerations induced by blast overpressure on soldiers wearing headborne equipment; design and evaluate reduced weight head and torso protection concepts for small arms and fragment protection using novel materials and assembling approaches; continue development of advanced modeling, simulation, and assessment tools that define ballistic and blast survivability/mobility/lethality trade space; develop a standardized methodology to assess anthropometric design (fit, area of coverage, and comfort) impacts on body armor system performance. *FY 2016 Plans:* Will 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.			
Title: Soldier Vision Protection and Enhancement *Description:* This effort focuses on technologies, which provide eye protection from battlefield threats. This effort supports Force Protection Soldier and Small Unit capability research and addresses the Army top challenge of easing overburdened Soldiers in small units. *FY 2014 Accomplishments:* Investigated and designed a vision enhancement lens concept that manipulates the visible electromagnetic spectrum to improve dismounted Soldier's ability to identify combatants and increases the multi-protective capability (e.g. ballistic, laser, environmental) of the baseline eyewear; conducted human research studies to explore how vision protection technologies enhance or detract from Soldier situational awareness. *FY 2015 Plans:*	3.291	3.511	4.140

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 I 2	R-1 Program Element (Number/Name) PE 0602786A I *Warfighter Technology*	Project (Number/Name) H98 I *Clothing & Equipm Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Mature active and passive technologies for providing improved eye protection against ballistic and laser threats; demonstrate proof of concept for active variable transmission lenses for enhanced situational awareness in rapidly changing light level conditions; develop novel spray coating process for producing optical quality films; investigate ballistic and optical properties of novel transparent composite materials and nanomaterials that can provide >50% increase in ballistic protection compared to current materials; investigate and determine 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:* Will develop 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; will investigate feasibility of enhancing soldier vision performance (e.g., on-demand telescopic vision capability) using waveplate technology.			
Title: Measurement, Prediction, and Improvement of Soldier Performance *Description:* This effort provides a comprehensive focus on human science methods (psychological, anthropometric, and psychophysical) and biomechanical models to assess human responses to sensory, physical, cognitive, and affective stimuli and stressors to support human systems design concepts for Soldier equipment and to enhance 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. This effort supports Force Protection Soldier & Small Unit capability research and addresses the Army top challenge of easing overburdened Soldiers in small units. *FY 2014 Accomplishments:* Validated mitigation techniques for enhancing human spatial memory and navigation using adaptive display technologies and nutritional intervention; investigated new mitigation techniques such as enhanced vision technologies and biomechanical, physiological, as well as neurophysiological markers of physical and cognitive fatigue; incorporated data on the effects of individual differences on cognitive state monitoring technologies and mitigation techniques (e.g., measure stress and panic responses through eye movements, inner ear temperature, etc.); integrated human performance data into performance models to enhance mission performance assessment and analysis for the Small Unit; designed and validated statistical human two dimensional and three dimensional models using updated Soldier anthropometric data to optimize the design, fit, and sizing of Soldier clothing and individual equipment; advanced methods for assessing encumbered anthropometry to enable improved design of manned platforms; investigated concepts for improved biofidelic human models. *FY 2015 Plans:* Develop 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; develop and evaluate metrics	5.460	4.174	8.668

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602786A *I Warfighter Technology*	**Project (Number/Name)** H98 *I Clothing & Equipm Tech*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
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; conduct trade analyses between mobility, lethality, survivability, and mission performance; investigate anthropometric approaches for developing improved fidelity models that address vital organ size and inform Soldier equipment engineering designs about location, fit, and coverage area; investigate potential for human performance applications through emerging fields such as non-medical synthetic biology. *FY 2016 Plans:* Will 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 emerging modeling and analytical techniques to increase scientific rigor of Soldier system experiments that reduce risk and cost of systems 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 3-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.			
Title: Advancements in Fibers, Textiles, and Materials for Soldier Protection *Description:* This effort focuses on technologies that aid in the design and evaluation of multifunctional protective materials and concealment concepts for Soldier clothing, equipment, and shelters. This effort supports Force Protection Soldier and Small Unit capability research. *FY 2014 Accomplishments:* Investigated cost effective textile-embedded power generation for integration of sensors/detectors into Soldier clothing to reduce power needs and Soldier carried weight; investigated metrics, methods, and treatments for multifunctional materials to enhance Soldier survivability and mission effectiveness by reducing probability of detection by battlefield sensors; validated novel flame resistant (FR) test methodologies for FR materials that more accurately measure thermal material properties and provide trade-off data for developing Soldier clothing; conducted experiments on multi-functional protective textiles and membranes to determine response to environmental extremes and microbial/insect threats to develop increased protection capabilities for emerging pathogenic threats to Soldiers and Small Units. *FY 2015 Plans:* Mature novel textile and fiber-based technologies to provide protection against multiple environmental threats to Soldiers and Small Units; investigate use of electrotextiles for providing protection to personnel and equipment against electromagnetic threats; investigates methods of incorporating anti-pathogenic functionality into textiles; investigate properties and methods of making	7.801	7.190	8.925

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602786A *I Warfighter Technology*	**Project (Number/Name)** H98 *I Clothing & Equipm Tech*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
novel multi-component fibers, nanofibers, and finished fabrics for use as Soldier protection against cuts/abrasion, cold weather environments, and pathogens; perform experimental proof of concept for thermal signature reduction technology concepts; develop predictive models for thermal signature performance of emerging materials; mature technologies and methods to improve visual signature management/camouflage; investigate inherently flame resistant fiber and novel coating technologies that provide significant performance improvements over Flame Resistant-Army Combat Uniform (FR-ACU) fabrics; investigate alternative fiber technologies for durable, wearable combat identification systems that enable improved visibility to friendly forces; characterize novel thermoelectric textile materials for wearable power generation and personal cooling applications. *FY 2016 Plans:* Will 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..			
Accomplishments/Planned Programs Subtotals	21.311	18.985	27.642

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army										**Date:** February 2015	
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602786A *I Warfighter Technology*					**Project (Number/Name)** H99 *I Joint Service Combat Feeding Technology*		

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
H99: *Joint Service Combat Feeding Technology*	-	5.751	3.029	3.310	-	3.310	4.919	5.030	5.066	5.164	-	-

Note
 Not applicable for this item.

A. Mission Description and Budget Item Justification
 This project investigates, develops, and evaluates novel ration packaging, combat feeding equipment/systems, and advanced food processing technologies to prolong shelf-life. This project also investigates technologies that detect food safety hazards on the battlefield and enhance quality, nutritional content and the variety of food items in military rations. Efforts funded in this project support all Military Services, the Special Operations Command, and the Defense Logistics Agency. The Army serves as Executive Agent for this Department of Defense (DoD) program, with oversight and coordination provided by the DoD Combat Feeding Research and Engineering Board. Technologies developed within this effort transition to PE 0603001A/Project C07 for maturation.

 Efforts in this program element support the Army science and technology Soldier/Squad portfolio.

 Work in this PE is fully coordinated with PE 0602787A/Project 869 (Medical Technology) and PE0603001A/Project C07.

 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 US Army Natick Soldier Research, Development, and Engineering Center (NSRDEC), Natick, MA, and this project has collaborative efforts with the US Army Research Institute for Environmental Medicine.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Joint Combat Feeding Equipment Technologies	2.320	-	-
Description: Beginning in FY15, this effort is renamed from Joint Combat Feeding Equipment Technologies to Joint Combat Feeding Equipment and Food Protection Technologies. This effort investigates technologies in support of DoD Veterinary Service Activity (VSA) to improve field detection and identification capabilities for the presence of chemical and biological threats in foods, and provide new tools/sensors for food inspectors. This effort additionally investigates equipment and energy technologies to expand capability and reduce the logistics footprint of Joint Services field feeding operations in a wide range of environmental and operational contexts. *FY 2014 Accomplishments:*			

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015	
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602786A *I Warfighter Technology*	**Project (Number/Name)** H99 *I Joint Service Combat Feeding Technology*	

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Investigated grey water recycling and repurposing technologies within field feeding operations to reduce the contingency basing footprint and cost; investigated logistical support and costs of novel JP8 fueled burner technologies within containerized field kitchen platforms to improve fuel efficiency and reduce troop to task ratio within contingency basing field feeding operations; identified technology gaps in kitchen platforms across Joint Forces to increase use of common kitchen components to improve mean-time between failure while increasing interoperability across Joint systems.			
Title: Joint Combat Feeding Equipment and Food Protection Technologies **Description:** Beginning in FY15, this effort is renamed from Joint Combat Feeding Equipment Technologies to Joint Combat Feeding Equipment and Food Protection Technologies. This effort investigates technologies in support of DoD VSA to improve field detection and identification capabilities for presence of chemical and biological threats in foods, and provide new tools/sensors for food inspectors. This effort additionally investigates equipment and energy technologies to expand capability and reduce logistics footprint of Joint Services field feeding operations in a wide range of environmental and operational contexts. **FY 2015 Plans:** Explore technology for elimination/prevention of pathogens in fresh fruit and vegetables; develop methods to significantly reduce detection times for viable pathogens; investigate novel technologies to promote Joint field feeding operations and reduce field feeding logistical footprint.	-	1.429	-
Title: Ration Stabilization, Packaging, Novel Nutrient Delivery, and Food Safety Technologies **Description:** Beginning in FY15, this effort is renamed from Ration Stabilization, Packaging, Novel Nutrient Delivery, and Food Safety Technologies to Ration Stabilization and Novel Nutrient Delivery Technologies. This effort investigates complementary food technologies to extend shelf life and improve nutritional content. This effort identifies and develops stabilization techniques and nutrient compositions to maximize the Warfighter's cognitive and physical performance on the battlefield and minimize nutritional degradation to optimize the Warfighter's health. **FY 2014 Accomplishments:** Investigated dehydration technologies to produce lighter weight, condensed, shelf-stable rations that reduce refrigeration requirements in field environments; explored methods of stabilizing amino acids within rations to ensure optimal nutritional absorption by the Warfighter based on results from the FY13 investigation of the simulated digestion model; evaluated cost and performance of new bio-based ration packaging solutions within ration platforms to improve ration shelf-stability and reduce lifecycle cost.	3.431	-	-
Title: Ration Stabilization and Novel Nutrient Delivery Technologies **Description:** Beginning in FY15, this effort is renamed from Ration Stabilization, Packaging, Novel Nutrient Delivery, and Food Safety Technologies to Ration Stabilization and Novel Nutrient Delivery Technologies. This effort investigates complementary food	-	1.600	-

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602786A *I Warfighter Technology*	**Project (Number/Name)** H99 *I Joint Service Combat Feeding Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
technologies. This effort identifies and develops stabilization techniques and nutrient compositions to maximize the Warfighter's cognitive and physical performance on the battlefield and minimize nutritional degradation to optimize the Warfighter's health. *FY 2015 Plans:* Explore nutrient delivery methods within rations to ensure optimal Warfighter nutrition and performance; investigate emerging technologies to produce lightweight, condensed, shelf-stable rations that reduce refrigeration requirements in field environments; explore novel processing and stabilization technologies to improve acceptability and increase consumption while meeting shelf-stability requirements, extending ration life-cycle, and reducing cost.			
Title: Joint Combat Feeding Technologies *Description:* Beginning in FY16, Joint Combat Feeding Equipment and Food Protection Technologies and Ration Stabilization, Packaging, Novel Nutrient Delivery, and Food Safety Technologies will be combined and named to Joint Combat Feeding Technologies. This effort will investigate emerging food technologies to identify and develop stabilization techniques and nutrient compositions to maximize the Warfighter's cognitive and physical performance on the battlefield and minimizes nutritional degradation to optimize the Warfighter's health. This effort will investigate technologies in support of VSA to improve field detection and identification capabilities for the presence of chemical and biological threats in foods and fund research in new tools/sensors for food inspectors. This effort additionally investigates equipment and energy technologies to expand capability and reduce logistics footprint of Joint Service field feeding operations in a wide range of environmental and operational contexts. *FY 2016 Plans:* Will 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 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.	-	-	3.310
Accomplishments/Planned Programs Subtotals	5.751	3.029	3.310

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

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** H99 / *Joint Service Combat Feeding Technology*

D. Acquisition Strategy

 N/A

E. Performance Metrics

 N/A

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Appropriation/Budget Activity 2040 I 2	R-1 Program Element (Number/Name) PE 0602786A I *Warfighter Technology*	Project (Number/Name) VT4 I *Expeditionary Mobile Base Camp Technology*

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
VT4: *Expeditionary Mobile Base Camp Technology*	-	1.525	1.338	1.758	-	1.758	2.481	3.225	3.152	3.216	-	-

Note

Not applicable for this item.

A. Mission Description and Budget Item Justification

This project matures and demonstrates fully integrated holistic expeditionary base camp (EBC) capabilities with mission-specific plug and play components, subsystems, and modules designed to optimize manpower requirements, improve 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 and require no Military Construction and limited materiel handing support. This project integrates mature technologies to create mission specific lab demonstrators and evaluates the performance capabilities using metrics and methodologies developed under PE 0603001A/Project VT5.

Efforts in this program element support the Army science and technology Soldier/Squad portfolio.

Work in this PE is fully coordinated with PE 0602786A (Warfighter Technology), PE 0602784A and 0603734A (Military Engineering), 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 US Army Natick Soldier Research, Development, and Engineering Center (NSRDEC), Natick, MA

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Expeditionary Base Camp Component Technologies	1.525	1.338	1.758
Description: This effort identifies and improves component interoperability and matures and scales component technologies for an integrated holistic base camp concept. This effort supports basing sustainment and logistics capability investigations. *FY 2014 Accomplishments:*			

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 I 2	R-1 Program Element (Number/Name) PE 0602786A I *Warfighter Technology*	Project (Number/Name) VT4 I *Expeditionary Mobile Base Camp Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Investigated self-sustaining living module concepts for experiments with technologies investigated in FY13 that reduce dependence on resupply at Contingency Bases by providing protection, water, energy efficiency, and power capabilities; validated protection, power, and other sustainment performance parameters measured in FY13. *FY 2015 Plans:* Investigate 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; explore self-sufficiency solutions that minimize logistical needs, as well as identify opportunities for co-generation and dual-use technology approaches; investigate the benefits of nonwoven textiles for potential shelter technology applications to achieve a 20% weight reduction over current woven fabrics. *FY 2016 Plans:* Will 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 burdens 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 through vector protections.			
Accomplishments/Planned Programs Subtotals	1.525	1.338	1.758

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army											Date: February 2015	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I BA 2: Applied Research*					**R-1 Program Element (Number/Name)** PE 0602787A *I Medical Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
Total Program Element	-	81.386	76.044	76.853	-	76.853	77.111	82.334	82.912	84.549	-	-
869: *Warfighter Health Prot & Perf Stnds*	-	34.032	31.594	30.043	-	30.043	27.052	29.771	29.988	30.580	-	-
870: *Dod Med Def Ag Inf Dis*	-	18.732	17.741	19.245	-	19.245	20.650	22.323	22.791	23.237	-	-
874: *Cbt Casualty Care Tech*	-	17.761	15.855	17.005	-	17.005	17.416	19.089	18.929	19.306	-	-
FH2: *Force Health Protection - Applied Research*	-	6.128	6.058	5.278	-	5.278	6.626	5.688	5.688	5.801	-	-
VB4: *System Biology And Network Science Technology*	-	4.733	4.796	5.282	-	5.282	5.367	5.463	5.516	5.625	-	-

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 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.

Project 870 designs and refines medical diagnostic assays/tests, drugs, and vaccines for protection from and treatment of naturally occurring diseases, 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, 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 and other blast related 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.

Project FH2 conducts applied research focused on sustainment of a healthy Warfighters throughout the entire deployment life cycle.

Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602787A *I Medical Technology*	

Project VB4 includes applied research in systems biology of military-relevant diseases such as Post Traumatic Stress Disorder (PTSD), coagulopathy (blood clotting disorders), suicide, and chronic pain. Another focus is environmental exposure toxicology (study of the biology of harm from toxic substances in the environment). The goals are to understand mechanisms (processes and pathways), develop molecular and physiological markers (biological molecules as indicators of the body's functions such as immune response) for future diagnostic systems, and identify therapeutic interventions supporting early decisions for therapeutic strategies. The core capability is a data system that integrates iterative (successively building upon data and results) biological tests, computer simulations, and animal studies, providing powerful analyses in support of research across United States Army Medical Research & Materiel Command. This project is being coordinated with the Defense Health Program.

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 U.S. Food and Drug Administration (FDA) or Environmental Protection Agency (EPA) regulations. The FDA requires thorough testing in animals (preclinical testing) to ensure safety and, where possible, effectiveness prior to evaluation in controlled human clinical trials (upon transition to 6.3 Advanced Technology Development). This PE focuses on research and refinement of technologies such as product formulation and purification and laboratory test refinement with the aim of identifying candidate solutions. This work often involves testing in animal models. The EPA also requires thorough testing of products, such as sterilants, disinfectants, repellents, and insecticides to ensure the environment is adequately protected before these products are licensed for use.

Program refinement and execution is externally peer-reviewed and fully coordinated with all Services as well as other agencies through the Joint Technology Coordinating Groups of the Armed Services Biomedical Research Evaluation and Management (ASBREM) Community of Interest (COI). The ASBREM COI, formed under the authority of the Assistant Secretary of Defense for Research and Engineering, serves to facilitate coordination and prevent unnecessary duplication of effort within the Department of Defenses (DoD) biomedical research and refinement community, as well as their associated enabling research areas.

Work funded in this 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; U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) and the Armed Forces Institute of Regenerative Medicine (AFIRM), Fort Detrick, MD; U.S. Army Center for Environmental Health Research (USACEHR), Fort Detrick, MD; U.S. Army Research Institute of Environmental Medicine (USARIEM), Natick, MA; the U.S. Army Dental Trauma Research Detachment and the U.S. Army Institute of Surgical Research (USAISR), Joint Base San Antonio-Fort Sam Houston, TX; U.S. Army Aeromedical Research Laboratory (USAARL), Fort Rucker, AL; and the Naval Medical Research Center (NMRC), Silver Spring, MD.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2016 Army			**Date:** February 2015	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*		**R-1 Program Element (Number/Name)** PE 0602787A *I Medical Technology*		
B. Program Change Summary ($ in Millions)	<u>FY 2014</u>	<u>FY 2015</u>	<u>FY 2016 Base</u>	<u>FY 2016 OCO</u>	<u>FY 2016 Total</u>
Previous President's Budget	93.290	76.068	77.330	-	77.330
Current President's Budget	81.386	76.044	76.853	-	76.853
Total Adjustments	-11.904	-0.024	-0.477	-	-0.477
• Congressional General Reductions	-	-0.024			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-9.773	-			
• SBIR/STTR Transfer	-2.131	-			
• Adjustments to Budget Years	-	-	-0.477	-	-0.477

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army											Date: February 2015	

Appropriation/Budget Activity 2040 *I* 2				R-1 Program Element (Number/Name) PE 0602787A *I Medical Technology*				Project (Number/Name) 869 *I Warfighter Health Prot & Perf Stnds*				

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
869: *Warfighter Health Prot & Perf Stnds*	-	34.032	31.594	30.043	-	30.043	27.052	29.771	29.988	30.580	-	-

A. Mission Description and Budget Item Justification

This project conducts research to prevent and protect Warfighers 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 Warfigher Systems Engineering Architecture task advances medical 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 Warfigher systems and the interactions between Warfighers and the systems they employ.

Promising efforts identified in this project are further matured under 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 U.S. Army Research Institute of Environmental Medicine (USARIEM), Natick, MA; U.S. Institute of Surgical Research (USAISR), Joint Base Sant Antonio-Fort Sam Houston, TX; and the U.S. 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.

B. Accomplishments/Planned Programs ($ in Millions)

	FY 2014	FY 2015	FY 2016
Title: Physiological Health - Nutritional Sustainment and Fatigue Interventions	5.984	3.610	2.617

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
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 2014	FY 2015	FY 2016
Description: This effort evaluates methods for managing and controlling the effects of nutrition and fatigue on Warfighter operational performance. *FY 2014 Accomplishments:* Established the nutritional requirements for optimizing Warfighter re-fueling; Military Dining Facility serving practices that promote healthy food choices; nutritional requirements for optimizing bone health; and developed dietary support interventions that accelerate cognitive recovery after operational stress. These interventions optimize Warfighter recovery from demanding missions through nutrition. Developed mathematical models and algorithms for prediction of cognitive resilience based on physiological factors identified in laboratory studies, which allowed resilience training to be personally optimized; compared the effectiveness and post-awakening performance profile of novel sleep-inducers against that of currently available pharmaceuticals, which determined the most efficient intervention for sleep induction; developed a mathematical method for estimating thermal-work strain from non-invasive measures such as heart rate, skin temperature, heat flux, without the use of thermometer pills, which allowed for the optimization of Warfighter load distribution and energy expenditure. *FY 2015 Plans:* Establish nutrition approaches that promoting resistance to physical, cognitive and environmental stressors and promote muscle and bone recovery. Develop next generation predictive algorithms that estimate overheating for incorporation into wearable sensor systems. Establish sensors and bio-mathematical models capable of predicting cognitive status and likelihood of risk for musculoskeletal (muscle, bone, tendons, and ligaments) injury. Determine patterns of physiological (human mechanical, physical, and biochemical functions), behavioral, and cognitive-affective responses in individuals during exposure to multiple stressors and develop a working operational definition of physiological resilience and algorithms to predict individualized resilience. *FY 2016 Plans:* Will determine the role of eating rate in energy balance. Will establish the effects of nutritional interventions on the localized immune response during wound healing. Will determine the effectiveness of novel feeding platforms (dining facility organization) for the improvement of dietary quality during garrison feeding. Will determine relevant predictors, moderators and outcome metrics that enhance the ability to predict a Warfighters capacity to recover quickly, both mentally and physically. Will establish a capability to sense and predict physiological responses in individual Warfighters following exposure to environmental stressors or during operational missions.			
Title: Environmental Health and Protection - Physiological (human physical and biochemical functions) Awareness Tools and Warrior Sustainment in Extreme Environments *Description:* This effort evaluates remote monitoring of Soldier physiological (human physical and biochemical functions) status and mitigating/eliminating the effects of heat, cold, altitude, and other environmental stressors on Soldier performance. *FY 2014 Accomplishments:*	1.892	1.337	1.446

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602787A *I Medical Technology*	**Project (Number/Name)** 869 *I Warfighter Health Prot & Perf Stnds*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Conducted studies to determine whether physiological fatigue in cold environments increases susceptibility to non-freezing cold injury, such as trenchfoot and hypothermia, and developed screening procedures to identify Warfighters most at risk for non-freezing cold injury. Continued studies to determine the impact of hypoxia (oxygen depletion) on peripheral blood flow responses and susceptibility to non-freezing cold injury. *FY 2015 Plans:* Identify physiological reflexes that improve hand and finger dexterity during cold exposure and refine localized heating strategies to improve dexterity in cold weather operations. Develop decision aids for trade-off analyses of the impact of body armor protection and load on aerobic performance capabilities in temperate and hot environments. Determine 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. Identify biomarkers (biologically derived indicator of a process, event or condition, e.g. protein) predictive of individual risk for developing acute mountain sickness at high altitude operations. *FY 2016 Plans:* Will perform laboratory and field studies to refine predictive models of altitude sickness, acclimatization status, and work performance at high altitude. Will develop a mobile application for a PC-based Altitude Readiness Management System decision aid, and automated altitude acclimatization monitor for a rapid ascent to high altitudes. Will 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. Will determine if localized warming that will improve peripheral blood circulation will also decrease susceptibility to non-freezing cold injury. Will establish the effectiveness of novel pharmaceutical treatments for heat injury in an animal model to inform the development of promising drug interventions proposed to reduce the severity or alleviate organ damage and enhance recovery.			
Title: Injury Prevention and Reduction - Neurosensory Injury Prevention *Description:* The Warrior Injury Assessment Manikin analyzes and models the effects of mechanical and operational stressors on Warfighter neurosensory and spine health. It also can models the effects of s acoustic and impact trauma, vibration, and jolt as stressors on the brain, spine, eyes, and hearing. *FY 2014 Accomplishments:* Developed improved eye protection standards and ophthalmic (pertaining to the eye) guidelines for protective eyewear that serves the various Warfighter occupations and developed hearing protection strategies for optimized active noise-reduction protection. Developed novel assessment methods to detect impulse noise exposures. Developed a computational fluid dynamic model of the eye to evaluate the effects of blast exposures to ocular tissue. *FY 2015 Plans:* Develop spinal injury criteria and protection assessment methodologies for military vehicle occupants. Develop methods for assessing the effectiveness of prevention strategies against hearing and vestibular (sensory system supporting movement and	8.006	2.489	3.463

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army			Date: February 2015		
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 2014	FY 2015	FY 2016
sense of balance, located in the inner ear) injuries. Develop assessment criteria for prediction of eye injury resulting from blunt, ballistic, and blast-wave forces, and determine injury prevention criteria for eye injury induced by repetitive blast exposures. ***FY 2016 Plans:*** Will perform crash and blast relevant vertical acceleration experiments to determine improved predictions and diagnostics of spinal injury. Will characterize middle ear function under impulse (sudden loud) noise for improvement of current hearing injury models. Will validate test criteria, and develop predictive ocular (eye) injury algorithm to evaluate protective eyewear.			
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 2014 Accomplishments:*** Developed a quantitative computational model that can predict physical performance and risk of injury of individual Warfighters and developed training strategies and/or dietary interventions to improve recovery following intense physical exercise. ***FY 2015 Plans:*** Develop mathematical models of functional neuromuscular adaptation following muscle injury and determine the effect of inflammatory processes on muscle repair and regeneration. These models will predict the relative risk of re-injury, and incomplete healing. Determine the modifiable and non-modifiable risk hazards for musculoskeletal injuries. ***FY 2016 Plans:*** Will 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. Will 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.	5.058	2.075	3.054
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. ***FY 2014 Accomplishments:*** Compared varying treatment protocols for their ability to positively affect RTD after injury and developed a toolkit for assessment that includes testing vision, hearing, and vestibular (sensory system supporting movement and sense of balance) function;	2.624	3.015	2.636

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Appropriation/Budget Activity 2040 I 2	R-1 Program Element (Number/Name) PE 0602787A I *Medical Technology*	Project (Number/Name) 869 I *Warfighter Health Prot & Perf Stnds*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
developed models that predict and prevent auditory (process of hearing) injury; and developed criteria to improve hearing conservation and guide development of hearing protection equipment for Warfighters. *FY 2015 Plans:* Characterize current Warfighter injury trends in training and operations contributing to lost duty days, reduced mission effectiveness, and occupational disability. Determine the effects of physical, auditory, and visual system injury on military occupational performance and define minimal pre-RTD performance standards Warfighter. Evaluate Warfighters with traumatic brain injury and co-morbid auditory or vision deficits. *FY 2016 Plans:* Will 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. Will 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 Traumatic Brain Injury. Will determine the effects of physical injury on military occupational performance and define minimal standards for Warfighter performance prior to returning to duty.			
Title: Psychological Health - Psychological Resilience *Description:* This effort refines, validates, and disseminates 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 interventions to enhance and sustain psychological resilience throughout the Warfighter's career. *FY 2014 Accomplishments:* Evaluated and determined optimal interventions for preventing and treating deployment-related PTSD and co-morbidities (more than one concurrent illness) to include medications, psychotherapy and medication combinations, and alternative therapy protocols, including internet- based cognitive (mental processes) therapy. These intervention strategies were used to optimize treatment outcomes and to implement more effective, efficient, and economical treatment regimens; benchmarked emerging behavioral health trends through rapid fielding assessment teams which informed resilience training modifications. This ensured rapid response to Warfighter needs and determined evidence-based recommendations for Warfighter reintegration strategies into their units and society; developed and refined evidence-based resilience training strategies for the deployment cycle; developed best practice recommendations to facilitate Warfighters receiving the best possible training and provider care; and assessed factors that contribute to return-to-duty decisions and researched criteria and tools to inform return-to-duty decisions following psychological injury and instilling confidence in the Warfighter and provider. *FY 2015 Plans:* Develop and disseminate validated strategies and early interventions to enhance and sustain mental health and well-being throughout service member's careers and determine evidence-based recommendations for reintegration strategies. Benchmark	8.272	14.493	12.960

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Appropriation/Budget Activity 2040 I 2	R-1 Program Element (Number/Name) PE 0602787A I *Medical Technology*	Project (Number/Name) 869 I *Warfighter Health Prot & Perf Stnds*	

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
behavioral health problems, risk, and resilience physiological biomarkers in Warfighters and their Families. Conduct analyses of neurocognitive (relating to or involving the central nervous system and cognitive abilities) test scores associated with a wide variety of psychological return-to-duty (RTD) outcomes. Conduct studies that explore the utility of sleep monitors and neurocognitive tools for psychological RTD decision making. Assess various mechanisms and interventions for reducing deployment-related anxiety. Develop and validate unit-based, post-deployment resilience training for Warfighters. Conduct trials with active duty Warfighters assessing optimal intervention methods for PTSD, including medications. Determine 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:* Will explore the effectiveness of improved sleep quality and quantity on the recovery from concussion. Will perform studies to improve a Mindfulness training package to develop recommendations for Comprehensive Warfighter and Family Fitness (CSF2). Will analyze data from previous studies to determine if an alcohol use screening questionnaire can be effectively used in Warfighters. Will perform studies to revise Family resilience training across the deployment cycle. Will develop evidence-based recommendations for identifying and addressing difficulties with post-combat adjustment. Will 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. Will perform studies to improve and validate unit-based resilience training for Reserve Components. Will begin to evaluate evidence-based behavioral health leader training. Will provide recommendations for provider toolkit using sleep quality parameters to inform return-to-duty decisions. Will conduct studies to understand how to best increase Warfighter use of DoD provided behavioral health care. Will extend the Systems Biology Enterprise (SBE) PTSD biomarker research to identify biomarker differences, based on gender; will biomarkers to 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. Will 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.			
Title: Psychological Health & Resilience - Suicide Prevention *Description:* This effort supports methods to identify causative and preventive factors in military suicides. *FY 2014 Accomplishments:* Tested the effectiveness of a brief, telephone-based intervention to increase behavioral health treatment-seeking among Service members at high risk of suicide; learned about the type and range of decisions made by behavioral healthcare providers, chaplains, and leaders to address suicide-related events that occur during deployment, the process for making those decisions,	0.994	1.000	0.865

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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 2014**	**FY 2015**	**FY 2016**
and the lessons learned; assessed how suicide-related events were managed and what could be improved; and developed guidelines and decision aids for use in deployed settings when suicide-related events occur.						
FY 2015 Plans: Determine risk and protective factors associated with suicide behavior and intent. Determine effective risk assessment and management methods for suicide prevention. Deliver 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: Will continue to advance the study from FY15 efforts to determine whether a brief cognitive behavioral intervention can encourage Warfighters to seek treatment. Will continue to develop evidence-based guidelines for leaders to manage suicide events.						
Title: Psychological Health & Resilience - Concussion/Mild Traumatic Brain Injury (mTBI) Interventions				1.202	1.076	0.876
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. *FY 2014 Accomplishments:* Conducted research to evaluate the utility of magnetoencephalography (MEG), (technique for mapping brain activity by recording magnetic fields produced by electrical currents occurring naturally in the brain), as a tool for differentiating PTSD from the brain injury, following a post-concussion event; compared two imaging techniques (MEG and functional magnetic resonance imaging) for effectively assessing brain injury following a post-concussion event. These efforts lead to more effective assessment of Warriors brain injury post-concussion and facilitate appropriate care. *FY 2015 Plans:* Characterize sleep duration, timing, and continuity on post-concussive symptoms using objective sleep measures. Determine the relative utility of existing neurocognitive tools for assessment of post-concussive symptoms. Develop algorithms to predict concussion likelihood based on post-exposure symptoms and brain injury *FY 2016 Plans:* Will 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: Soldier Systems Engineering Architecture				-	2.499	2.126
Description: This effort will advance medical S&T in the areas of injury prevention and performance sustainment. *FY 2015 Plans:*						

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B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Advance medical S&T in the areas of injury prevention and performance sustainment in the context of human interaction with new Warfighter systems. Provide 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. Leverages 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:* Will 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 will leverage 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.			
Accomplishments/Planned Programs Subtotals	34.032	31.594	30.043

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 *I* 2					**R-1 Program Element (Number/Name)** PE 0602787A *I Medical Technology*					**Project (Number/Name)** 870 *I Dod Med Def Ag Inf Dis*		
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
870: *Dod Med Def Ag Inf Dis*	-	18.732	17.741	19.245	-	19.245	20.650	22.323	22.791	23.237	-	-

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 five areas:

(1) Drugs to Prevent/Treat Parasitic (organisms living in or on another organisms) Diseases
(2) Vaccines for Prevention of Malaria
(3) Diagnostics and Disease Transmission Control
(4) Bacterial Disease Threats (diseases caused by bacteria)
(5) Viral Disease Threats (diseases caused by viruses)

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 U.S. 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 U.S. 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.

Promising medical countermeasures identified in this project are further matured under PE 0603002A, project 810.

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
Appropriation/Budget Activity 2040 *I* 2	R-1 Program Element (Number/Name) PE 0602787A *I Medical Technology*	Project (Number/Name) 870 *I Dod Med Def Ag Inf Dis*	

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 Naval Medical Research Center (NMRC), Silver Spring, MD, and its overseas laboratories.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Title: Drugs to Prevent/Treat Parasitic Diseases	4.386	3.359	5.304
Description: This effort conducts assessments on and improves candidate drugs coming from the DoD discovery program and from other collaborations for prevention and treatment of malaria to counter the continuing spread of drug resistance to current drugs; conducts assessments in animal models of currently available drugs for use against cutaneous leishmaniasis (a skin-based disease transmitted by sand flies); and selects the most effective and safe candidates for continued refinement and possible clinical testing. **FY 2014 Accomplishments:** Tested new refined anti-malaria and anti-leishmania candidate drug treatments in animal models for safety and effectiveness **FY 2015 Plans:** Continue to optimize candidate drugs and drug combinations to stay ahead of emerging drug resistance in malaria parasite(s). **FY 2016 Plans:** Will 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. Will evaluate safety and effectiveness of lead 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).			
Title: Vaccines for Prevention of Malaria	4.126	4.829	4.025
Description: This effort conducts studies to investigate new candidate vaccines for preventing malaria and selects the best candidate(s) for continued refinement. A highly effective vaccine would reduce or eliminate the use of anti-malarial drugs and would minimize the progression and impact of drug resistance to current/future drugs. **FY 2014 Accomplishments:** Assessed immune responses of candidate antigens (substance, usually a protein, that stimulates an immune response generating an antibody that recognizes the antigen) and adjuvant (agent that enhances the immune response, usually used with a vaccine			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015	
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / Medical Technology	Project (Number/Name) 870 / Dod Med Def Ag Inf Dis	

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
antigen) formulations to optimize immunogenicity (a substances ability to provoke an immune response) and effectiveness in animal challenge models. *FY 2015 Plans:* : Complete the development of a human challenge model for malaria; volunteers vaccinated with a malaria vaccine candidate are deliberately infected with a malarial parasite through the bite of malaria-infected mosquitoes to assess whether or not the candidate vaccine can prevent or delay malaria infection. Test individual novel Plasmodium falciparum (causes severe form of malaria) antigens and antigen combinations in small animals. *FY 2016 Plans:* Will assess mechanisms of protective immunity of new malaria protein-based vaccine candidates in small animals. Will evaluate immune response of human volunteers successfully protected from infection by weakened sporozoite s (infective stage of malaria parasite transmitted by mosquitoes), to discriminate protective from non-protective immune responses.			
Title: Diagnostics and Disease Transmission 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 2014 Accomplishments:* Incorporated the methods and assays for detecting & identifying the vector(s) (organisms that transmit infections) of interest and assays for detecting pathogens into the next-generation diagnostic system (NGDS) managed by Joint Program Executive Office for Chemical Biological Defense. Completed the dengue assay for use on mosquito samples determine if they are carrying Dengue virus. *FY 2015 Plans:* Research and develop pathogen specific assays for selected disease causing pathogens to expand the capability of the fielded and commercially available Rapid Human Diagnostic Devices (RHDDs). Refine pathogen detection assays and field test surveillance devices developed to detect pathogens in medically important arthropods (e.g., ticks, mosquitoes and sandflies). Test new vector repellent compounds/formulations for application to personal protection measures i.e. uniform treatment or bednets. *FY 2016 Plans:* Will develop tests to detect arthropod-borne pathogens for use on field deployable detection platform. Will develop a multiplex assay (capable of detecting multiple pathogens at the same time). Will conduct field evaluations for the rapid surveillance test to detect Chikungunya virus.	2.005	1.679	1.244
Title: Viral Threats Research	3.706	3.744	3.241

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Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / Medical Technology	Project (Number/Name) 870 / Dod Med Def Ag Inf Dis

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
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 2014 Accomplishments:* Identified and developed reagents, assays, and animal models to test the immunogenicity and protective effectiveness of candidate vaccines and other medical countermeasures against hemorrhagic fever viruses of military interest. *FY 2015 Plans:* Identify and maintain vaccine test site infrastructure for evaluation of dengue vaccine candidates in human clinical trials. Assess vaccination safety and immunogenicity data, applying 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. Test research strategies to develop novel assays to rapidly measure hantavirus neutralizing antibodies. *FY 2016 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 E. coli, Campylobacter and Shigella), wound infection and scrub typhus (a debilitating mite-borne disease). *FY 2014 Accomplishments:* Evaluated new anti-diarrhea vaccine candidates, for Shigella, Campylobacter and E. coli, in animal models. Evaluated safety and toxicity of selected vaccine antigens in small animals to further down-select best candidates for future human testing. *FY 2015 Plans:*	4.509	4.130	5.431

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Refine and evaluate vaccine candidates for Shigella and enterotoxigenic E. coli. Study clinical grade prototype diarrheal disease vaccine candidates for animal testing. Identify and prepare vaccination field trial sites. Maintain chigger (mite) colony used as the challenge model to evaluate current Scrub typhus vaccine candidates. Identify and characterize mechanisms of antibiotic resistance occurring in scrub typhus infections. ***FY 2016 Plans:*** Based on down-selection from FY15vaccine formulations, will refine and evaluate vaccine candidates against each of the three major bacterial causes of diarrhea (Shigella, enterotoxigenic E. coli and Campylobacter). Will study clinical grade (suitable for injection into human volunteers) diarrheal disease vaccine candidates in small animals for safety and effectiveness. Will identify and prepare clinical trial field sites for evaluation of candidate vaccines. Will maintain a chigger colony used as the challenge model to evaluate the effectiveness of Scrub typhus vaccine candidates. Will study the mechanisms of immune protection to scrub typhus.			
Accomplishments/Planned Programs Subtotals	18.732	17.741	19.245

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army										**Date:** February 2015	
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602787A *I Medical Technology*					**Project (Number/Name)** 874 *I Cbt Casualty Care Tech*		
COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
874: *Cbt Casualty Care Tech*	-	17.761	15.855	17.005	-	17.005	17.416	19.089	18.929	19.306	-	-

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, revival and stabilization, predictive indicators and decision aids for life support systems , treatment of burns, and traumatic brain injury (TBI). Clinical and rehabilitative medicine research addresses tissue repair 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
(5) Traumatic Brain Injury

All drugs, biological products, and medical devices are refined in accordance with FDA regulations, which govern testing in animals to assess safety, toxicity, and effectiveness and subsequent human subject clinical trials.

Promising efforts identified in this project are further matured under PE 0603002A, 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 U.S. Army Institute of Surgical Research (USAISR), the U.S. Army Dental Trauma Research Detachment (USADTRD), Joint Base San Antonio-Fort Sam Houston, TX; the Walter Reed Army Institute of Research (WRAIR), Silver Spring, MD; and the AFIRM, Fort Detrick, MD.

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 2014	FY 2015	FY 2016
Title: Damage Control Resuscitation	3.100	3.675	3.903

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
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 2014 Accomplishments:* Continued validation studies of portable, rapid, point-of-care devices that provide care givers information on clotting ability to guide resuscitation. Performed studies on blood product storage using technologies suitable for use under battlefield conditions. *FY 2015 Plans:* Conduct studies to determine effective means to control bleeding when clotting ability is been impaired due to trauma. Conduct 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 will improve soldier trauma survival and improve longer term treatment / recovery. *FY 2016 Plans:* Will start animal studies to explore clinical consequences of long-term application of hemorrhage (bleeding) control products and devices. Will 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.			
Title: Combat Trauma Therapies	0.592	1.245	1.395
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 2014 Accomplishments:* Formulated an anti-biofilm (an aggregate of microorganisms in which cells adhere to each other on a surface) gel to combat wound infections, prevent chronic infections, and hasten wound healing. *FY 2015 Plans:* Continue development of anti-biofilm gel. Perform studies to determine means to alleviate persistent wound inflammation subsequently preventing tissue destruction and excessive scarring. *FY 2016 Plans:* Will 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 excessive scarring. Will start animal wound healing studies using combinations of skin components to evaluate effects on wound contraction and scarring.			
Title: Combat Critical Care Engineering	1.779	1.369	1.993

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Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
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 2014 Accomplishments:* Worked to optimize algorithms to improve fluid resuscitation and prevent hemorrhagic shock and developed decision support algorithms to guide provision of critical care to casualties at the point of injury, during transport, and in field hospital. *FY 2015 Plans:* Conduct studies to identify the physiological effects of optimizing blood flow returning to the heart, as a fluidless resuscitation strategy. Continue 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 continue studies from FY15 to identify the physiological effects of optimizing blood flow returning to the heart, as a fluidless resuscitation strategy. Will complete development of first generation patient monitors using light-based sensors and integration of blood-loss prediction algorithm. Will 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.			
Title: Clinical and Rehabilitative Medicine *Description:* This effort conducts laboratory and animal studies on regenerating skin, muscle, nerve, bone tissue, and soft tissue (e.g. skin and muscle, including the genitalia and abdomen) as well as studies regarding ocular (eye) and visual system traumatic injury for the care and treatment of battle-injured casualties. *FY 2014 Accomplishments:* : Down-selected novel drug delivery, diagnostic, tissue repair, and treatment strategies including drug and stem cell therapies for eye trauma. Refined and developed novel drug delivery, diagnostic, reconstructive, and regenerative strategies. Utilized and refined cell-based therapies (including stem cells; primitive cells that give rise to more specialized cell types as they develop) and tissue scaffolds (tissue-engineered grafts) in animal models to assess soft and hard tissue (e.g. bone) repair and regeneration. Exploited FY13 work evaluated burn and wound- healing bone and soft tissue repair candidate strategies and strategies to repair extremities (arms and legs), craniomaxillofacial (head, neck, face and jaw), genital, and abdominal regions. *FY 2015 Plans:*	10.333	7.552	7.522

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 874 / *Cbt Casualty Care Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
Down-select and further develop drug delivery, diagnostic, tissue repair, and treatment strategies including drugs and stem cell therapies for eye trauma. Based on FY14 work, evaluate 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:* Will down-select and further develop drug delivery, diagnostic, tissue repair, and treatment strategies including drugs and stem cell therapies for eye trauma. Will evaluate candidate strategies for burn injury, bone and soft tissue repair, and strategies to address injury to the extremities, craniomaxillofacial, genital, and abdominal regions. Studies to determine the applicability of using stem cells to repair or restore skin, testicular, muscle, and bone tissues will advance 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 *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 brain injury resulting from battlefield trauma. *FY 2014 Accomplishments:* Developed selective brain cooling and nerve stem cell transplantation as non-traditional therapies for Traumatic Brain Injury (TBI) and combat-relevant animal model of repeated mild TBI (mTBI) / concussion. *FY 2015 Plans:* Continue 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:* Will down-select candidate drugs and other treatment strategies for treatment of TBI. Will characterize polytrauma (multiple trauma injuries)/TBI animal models to develop potential TBI drug treatments. Will 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.	1.957	2.014	2.192
Accomplishments/Planned Programs Subtotals	17.761	15.855	17.005

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

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 874 / *Cbt Casualty Care Tech*

D. Acquisition Strategy

 N/A

E. Performance Metrics

 N/A

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army										**Date:** February 2015	
Appropriation/Budget Activity 2040 *I* 2				**R-1 Program Element (Number/Name)** PE 0602787A *I Medical Technology*				**Project (Number/Name)** FH2 *I Force Health Protection - Applied Research*			

COST ($ in Millions)	**Prior Years**	**FY 2014**	**FY 2015**	**FY 2016 Base**	**FY 2016 OCO**	**FY 2016 Total**	**FY 2017**	**FY 2018**	**FY 2019**	**FY 2020**	**Cost To Complete**	**Total Cost**
FH2: *Force Health Protection - Applied Research*	-	6.128	6.058	5.278	-	5.278	6.626	5.688	5.688	5.801	-	-

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 Soldiers 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 PE 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 U.S. Army Center for Environmental Health Research (USACEHR), Fort Detrick, MD; the Naval Health Research Center (NHRC), San Diego, CA; and the U.S. 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.

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Title: Millennium Cohort Research	4.385	4.585	4.796

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602787A *I Medical Technology*	**Project (Number/Name)** FH2 *I Force Health Protection - Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2014	FY 2015	FY 2016
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. *FY 2014 Accomplishments:* Determined the long-term and ongoing functional, physical, and mental health issues of Service members (including injury and respiratory/environmental exposures) after military experiences including deployments, training, and other exposures of concern and characterize emerging or high-profile health threats among Service members through longitudinal assessment. These results informed preventive and intervention strategies to ensure a healthy and fit force and aided providers and leadership in mitigating adverse health outcomes associated with military experiences. *FY 2015 Plans:* Will evaluate the impact of child health on Family functioning and Service Member health outcome and investigate the impact of the Family's response to deployment on the mental health of the deployed Service Member. *FY 2016 Plans:* Will continue the FY15 evaluation of the impact of child health on Family functioning and Service Member health outcomes and investigate the impact of the Family's response to deployment on the mental health of the deployed Service Member. Will 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). Will evaluate long-term functional and physical health of early cohort deployed Service Member. Will assess negative coping behaviors such as misuse of alcohol and tobacco use in Service Member cohorts and likelihood of utilizing Department of Veterans Affairs (VA) health services.			
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 environmental contamination and toxic exposure during military operations. *FY 2014 Accomplishments:*	0.698	-	-

Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602787A *I Medical Technology*	**Project (Number/Name)** FH2 *I Force Health Protection - Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
Applied a risk ranking system to provide a screening-level assessment for hazardous exposures to the identified Army nanomaterials (materials smaller than a one tenth of a micrometer in at least one dimension). These studies identified Army nanomaterials associated with having the highest initial risk rankings of potential exposures to Warfighters.			
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. . *FY 2014 Accomplishments:* Developed musculoskeletal models for predicting individualized physical performance outcomes of military-relevant tasks following blast or blunt impacts. This research showed the physical decrement associated with blast or blunt impact exposure. *FY 2015 Plans:* Develop models to assess endurance for military relevant tasks including algorithm development to predict musculoskeletal adaptations to fatigue. Expand 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:* Will refine performance models developed in FY15, that assessed endurance for military relevant tasks including algorithm development to predict musculoskeletal adaptations to fatigue. Will refine biomechanical performance models developed in FY15, to incorporate military relevant tasks, such as lifting and marksmanship that use the upper body and core.	1.045	1.473	0.482
Accomplishments/Planned Programs Subtotals	6.128	6.058	5.278

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 2016 Army											Date: February 2015	
Appropriation/Budget Activity 2040 I 2					**R-1 Program Element (Number/Name)** PE 0602787A I *Medical Technology*					**Project (Number/Name)** VB4 I *System Biology And Network Science Technology*		

COST ($ in Millions)	Prior Years	FY 2014	FY 2015	FY 2016 Base	FY 2016 OCO	FY 2016 Total	FY 2017	FY 2018	FY 2019	FY 2020	Cost To Complete	Total Cost
VB4: *System Biology And Network Science Technology*	-	4.733	4.796	5.282	-	5.282	5.367	5.463	5.516	5.625	-	-

A. Mission Description and Budget Item Justification

This projects efforts support applied research. The primary capability of systems biology (field of study that focuses on complex interactions within biological systems, using a holistic approach) is to integration and analysis of complex human and animal study data and development of computational disease models, providing a method to discriminate unique combinations of biological molecules corresponding to clinical conditions, 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 (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 US Army Medical Research and Materiel Command (USAMRMC), Fort Detrick, MD / US 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 2014	FY 2015	FY 2016
Title: Systems Biology	4.733	4.796	5.282
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 us to 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			

Exhibit R-2A, RDT&E Project Justification: PB 2016 Army		Date: February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602787A *I Medical Technology*	**Project (Number/Name)** VB4 *I System Biology And Network Science Technology*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
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. *FY 2014 Accomplishments:* Continued to adapt novel state-of-the-art approaches to enable use of clinical samples from illness or diseases of military relevance, including the technology of the SysBioCube database, (data management and analytic system) to further the aims of clinical data integration with the massive datasets from multi-omic (interrelated "omic" fields such as proteomics, genomics, and others) approaches and other physiologic findings. Via computer analysis evaluated high-content data sets from environmental exposures to identify physiological responses-specific to the exposure to toxic substances. Screened / down-selected candidate PTSD and coagulopathy (abnormal blood clotting) biomarkers for further analysis and validation of the reproducibility of diagnostic results. *FY 2015 Plans:* Design and utilize 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. Evaluate and integrate computer modeling with high-content global molecular data sets from PTSD clinical studies and utilize PTSD animal models to further therapeutic studies / Follow the successful pattern of combining clinical trials with animal models, applying this to study coagulopathy and mechanisms of chronic pain. Develop and enhance capabilities to support transition of research to advanced development by incorporating newly emerging digital FDA-approved approaches. Evaluate high-content data sets from environmental exposures using computational platforms to identify biomarkers altered in physiological pathways and develop 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. Verify the pathway(s) (through tissues/cells) that a toxic substance exerts its effects and validate biomarkers of that effect in the rodent model. *FY 2016 Plans:* Will improve and apply tools in the SysBioCube to begin to define unique molecular patterns / signatures related to suicidality (the likelihood of someone attempting vs. completing suicide), coagulopathy, and chronic pain. Will evaluate and model molecular data from PTSD clinical studies to further define signatures within PTSD sufferers into distinct subgroups. Will further refine PTSD diagnostic biomarkers, to improve therapeutic drug effectiveness and support therapeutic drug discovery. Will use PTSD biomarker in animal models to verify new therapeutic drug targeting. Will construct a Laboratory Developed test for PTSD using commercial off-the-shelf technology, and evaluate it in selected medical treatment facilities; will continue to advance tests for identification of subgroups of PTSD to aid in informing appropriate therapeutic approaches and pursue FDA approval. Will begin			

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Exhibit R-2A, **RDT&E Project Justification:** PB 2016 Army		**Date:** February 2015
Appropriation/Budget Activity 2040 *I* 2	**R-1 Program Element (Number/Name)** PE 0602787A *I Medical Technology*	**Project (Number/Name)** VB4 *I System Biology And Network Science Technology*

B. Accomplishments/Planned Programs ($ in Millions)	**FY 2014**	**FY 2015**	**FY 2016**
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.			
Accomplishments/Planned Programs Subtotals	4.733	4.796	5.282

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

D. Acquisition Strategy
 N/A

E. Performance Metrics
 N/A

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