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**Department of Defense  
Fiscal Year (FY) 2015 Budget Estimates**

March 2014



**Army**

*Justification Book*

***Research, Development, Test & Evaluation, Army***

**RDT&E – Volume I, Budget Activity 1**

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**RESEARCH, DEVELOPMENT, TEST AND EVALUATION, ARMY**

**APPROPRIATION LANGUAGE**

For expenses necessary for basic and applied scientific research, development, test and evaluation, including maintenance, rehabilitation, lease, and operation of facilities and equipment, \$6,593,898,000, to remain available for obligation until September 30, 2016.

The following Justification Books were prepared at a cost of \$139,860.00: 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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 Total Obligational Authority  
 (Dollars in Thousands)

February 28, 2014

Appropriation -----	FY 2013 (Base & OCO) -----	FY 2014 Base Enacted -----	FY 2014 OCO Enacted -----	FY 2014 Total Enacted -----	FY 2015 Base -----
Research, Development, Test & Eval, Army	8,010,810	7,122,681	13,500	7,136,181	6,593,898
Total Research, Development, Test & Evaluation	8,010,810	7,122,681	13,500	7,136,181	6,593,898

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Summary Recap of Budget Activities -----	FY 2013 (Base & OCO)	FY 2014 Base Enacted	FY 2014 OCO Enacted	FY 2014 Total Enacted	FY 2015 Base
Basic Research	384,636	436,493		436,493	424,176
Applied Research	910,391	954,451		954,451	862,611
Advanced Technology Development	961,060	1,063,636		1,063,636	917,791
Advanced Component Development & Prototypes	421,655	408,552	6,500	415,052	323,156
System Development & Demonstration	2,785,237	2,052,576	7,000	2,059,576	1,719,374
RDT&E Management Support	1,241,684	1,163,091		1,163,091	1,000,430
Operational Systems Development	1,306,147	1,043,882		1,043,882	1,346,360
Total Research, Development, Test & Evaluation	8,010,810	7,122,681	13,500	7,136,181	6,593,898
 Summary Recap of FYDP Programs -----					
Strategic Forces	142,508	83,406		83,406	54,076
General Purpose Forces	610,249	575,129		575,129	963,970
Intelligence and Communications	383,165	208,332		208,332	170,244
Research and Development	6,821,245	6,199,708	13,500	6,213,208	5,329,383
Central Supply and Maintenance	53,461	56,106		56,106	76,225
Administration and Associated Activities	182				
Total Research, Development, Test & Evaluation	8,010,810	7,122,681	13,500	7,136,181	6,593,898

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

Line No	Program Element Number	Item	Act	FY 2013 (Base & OCO)	FY 2014 Base Enacted	FY 2014 OCO Enacted	FY 2014 Total Enacted	FY 2015 Base
1	0601101A	In-House Laboratory Independent Research	01	18,836	21,792		21,792	13,464
2	0601102A	Defense Research Sciences	01	197,690	221,783		221,783	238,167
3	0601103A	University Research Initiatives	01	72,243	79,317		79,317	69,808
4	0601104A	University and Industry Research Centers	01	95,867	113,601		113,601	102,737
		Basic Research		384,636	436,493		436,493	424,176
5	0602105A	Materials Technology	02	54,578	55,569		55,569	28,006
6	0602120A	Sensors and Electronic Survivability	02	40,842	43,148		43,148	33,515
7	0602122A	TRACTOR HIP	02	20,638	36,273		36,273	16,358
8	0602211A	Aviation Technology	02	46,828	55,586		55,586	63,433
9	0602270A	Electronic Warfare Technology	02	13,838	17,575		17,575	18,502
10	0602303A	Missile Technology	02	43,277	59,500		59,500	46,194
11	0602307A	Advanced Weapons Technology	02	23,140	26,148		26,148	28,528
12	0602308A	Advanced Concepts and Simulation	02	21,075	24,051		24,051	27,435
13	0602601A	Combat Vehicle and Automotive Technology	02	62,267	64,555		64,555	72,883
14	0602618A	Ballistics Technology	02	55,113	75,263		75,263	85,597
15	0602622A	Chemical, Smoke and Equipment Defeating Technology	02	4,010	4,487		4,487	3,971
16	0602623A	Joint Service Small Arms Program	02	6,378	7,814		7,814	6,853
17	0602624A	Weapons and Munitions Technology	02	46,097	52,778		52,778	38,069
18	0602705A	Electronics and Electronic Devices	02	85,099	58,990		58,990	56,435
19	0602709A	Night Vision Technology	02	48,069	43,403		43,403	38,445
20	0602712A	Countermines Systems	02	28,875	30,563		30,563	25,939

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21	0602716A	Human Factors Engineering Technology	02	18,161	21,328		21,328	23,783
22	0602720A	Environmental Quality Technology	02	18,259	20,304		20,304	15,659
23	0602782A	Command, Control, Communications Technology	02	26,200	34,191		34,191	33,817
24	0602783A	Computer and Software Technology	02	8,886	10,434		10,434	10,764
25	0602784A	Military Engineering Technology	02	71,553	70,027		70,027	63,311
26	0602785A	Manpower/Personnel/Training Technology	02	15,979	17,645		17,645	23,295
27	0602786A	Warfighter Technology	02	53,206	31,529		31,529	25,751
28	0602787A	Medical Technology	02	98,023	93,290		93,290	76,068
		Applied Research		910,391	954,451		954,451	862,611
29	0603001A	Warfighter Advanced Technology	03	36,975	66,025		66,025	65,139
30	0603002A	Medical Advanced Technology	03	99,924	100,999		100,999	67,291
31	0603003A	Aviation Advanced Technology	03	57,364	81,037		81,037	88,990
32	0603004A	Weapons and Munitions Advanced Technology	03	69,788	73,885		73,885	57,931
33	0603005A	Combat Vehicle and Automotive Advanced Technology	03	128,463	146,992		146,992	110,031
34	0603006A	Space Application Advanced Technology	03	3,702	5,862		5,862	6,883
35	0603007A	Manpower, Personnel and Training Advanced Technology	03	8,756	7,796		7,796	13,580
36	0603008A	Electronic Warfare Advanced Technology	03	45,254	45,394		45,394	44,871
37	0603009A	TRACTOR HIKE	03	6,792	9,161		9,161	7,492
38	0603015A	Next Generation Training & Simulation Systems	03	15,404	13,620		13,620	16,749
39	0603020A	TRACTOR ROSE	03	8,762	10,662		10,662	14,483
40	0603105A	Military HIV Research	03	20,920				

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41	0603125A	Combating Terrorism - Technology Development	03	9,199	15,046		15,046	24,270
42	0603130A	TRACTOR NAIL	03	3,207	3,192		3,192	3,440
43	0603131A	TRACTOR EGGS	03	2,560	2,366		2,366	2,406
44	0603270A	Electronic Warfare Technology	03	19,561	25,335		25,335	26,057
45	0603313A	Missile and Rocket Advanced Technology	03	80,379	83,975		83,975	44,957
46	0603322A	TRACTOR CAGE	03	12,026	11,077		11,077	11,105
47	0603461A	High Performance Computing Modernization Program	03	202,969	220,565		220,565	181,609
48	0603606A	Landmine Warfare and Barrier Advanced Technology	03	24,448	22,794		22,794	13,074
49	0603607A	Joint Service Small Arms Program	03	5,478	5,027		5,027	7,321
50	0603710A	Night Vision Advanced Technology	03	33,328	44,387		44,387	44,138
51	0603728A	Environmental Quality Technology Demonstrations	03	12,398	11,739		11,739	9,197
52	0603734A	Military Engineering Advanced Technology	03	30,503	23,705		23,705	17,613
53	0603772A	Advanced Tactical Computer Science and Sensor Technology	03	22,900	32,995		32,995	39,164
		Advanced Technology Development		961,060	1,063,636		1,063,636	917,791
54	0603305A	Army Missile Defense Systems Integration	04	22,340	23,289		23,289	12,797
55	0603308A	Army Space Systems Integration	04	9,038	13,584		13,584	13,999
56	0603619A	Landmine Warfare and Barrier - Adv Dev	04	4,089				
57	0603627A	Smoke, Obscurant and Target Defeating Sys-Adv Dev	04	2,430				
58	0603639A	Tank and Medium Caliber Ammunition	04	27,114	30,596		30,596	29,334
59	0603653A	Advanced Tank Armament System (ATAS)	04	11,116	49,963		49,963	
60	0603747A	Soldier Support and Survivability	04	15,936	5,185	6,500	11,685	9,602

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61	0603766A	Tactical Electronic Surveillance System - Adv Dev	04	7,960	6,890		6,890	8,953
62	0603774A	Night Vision Systems Advanced Development	04	9,556	9,061		9,061	3,052
63	0603779A	Environmental Quality Technology - Dem/Val	04	4,060	2,631		2,631	7,830
64	0603782A	Warfighter Information Network-Tactical - DEM/VAL	04	161,505	122,319		122,319	
65	0603790A	NATO Research and Development	04	4,393	3,872		3,872	2,954
66	0603801A	Aviation - Adv Dev	04	7,227	5,015		5,015	
67	0603804A	Logistics and Engineer Equipment - Adv Dev	04	13,028	11,549		11,549	13,386
68	0603805A	Combat Service Support Control System Evaluation and Analysis	04	4,499				
69	0603807A	Medical Systems - Adv Dev	04	22,514	15,594		15,594	23,659
70	0603827A	Soldier Systems - Advanced Development	04	30,793	14,152		14,152	6,830
71	0603850A	Integrated Broadcast Service	04	96	79		79	
72	0604100A	Analysis Of Alternatives	04					9,913
73	0604115A	Technology Maturation Initiatives	04	12,636	11,110		11,110	74,740
74	0604120A	Assured Positioning, Navigation and Timing (PNT)	04					9,930
75	0604131A	TRACTOR JUTE	04	54				
76	0604319A	Indirect Fire Protection Capability Increment 2-Intercept (IFPC2)	04	25,710	79,190		79,190	96,177
77	0604785A	Integrated Base Defense (Budget Activity 4)	04	3,604	4,473		4,473	
78	0305205A	Endurance UAVs	04	21,957				
	Advanced Component Development & Prototypes			421,655	408,552	6,500	415,052	323,156
79	0604201A	Aircraft Avionics	05	60,472	76,547		76,547	37,246
80	0604220A	Armed, Deployable Helos	05	80,934	69,807		69,807	

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81	0604270A	Electronic Warfare Development	05	102,812	144,543		144,543	6,002
82	0604280A	Joint Tactical Radio	05		31,809		31,809	9,832
83	0604290A	Mid-tier Networking Vehicular Radio (MNVR)	05	2,556	23,328		23,328	9,730
84	0604321A	All Source Analysis System	05	5,601	4,837		4,837	5,532
85	0604328A	TRACTOR CAGE	05	11,297	23,829		23,829	19,929
86	0604601A	Infantry Support Weapons	05	83,224	85,054		85,054	27,884
87	0604604A	Medium Tactical Vehicles	05	2,908	2,139		2,139	210
88	0604611A	JAVELIN	05	4,540	5,000		5,000	4,166
89	0604622A	Family of Heavy Tactical Vehicles	05	17,975	21,310	7,000	28,310	12,913
90	0604633A	Air Traffic Control	05	10,140	514		514	16,764
91	0604641A	Tactical Unmanned Ground Vehicle (TUGV)	05	2,795				6,770
92	0604710A	Night Vision Systems - Eng Dev	05	29,352	43,382		43,382	65,333
93	0604713A	Combat Feeding, Clothing, and Equipment	05	1,901	1,938		1,938	1,335
94	0604715A	Non-System Training Devices - Eng Dev	05	40,470	18,971		18,971	8,945
95	0604716A	Terrain Information - Eng Dev	05	928				
96	0604741A	Air Defense Command, Control and Intelligence - Eng Dev	05	42,876	18,284		18,284	15,906
97	0604742A	Constructive Simulation Systems Development	05	25,828	17,004		17,004	4,394
98	0604746A	Automatic Test Equipment Development	05	10,307	6,697		6,697	11,084
99	0604760A	Distributive Interactive Simulations (DIS) - Eng Dev	05	12,427	12,569		12,569	10,027
100	0604780A	Combined Arms Tactical Trainer (CATT) Core	05	16,005	27,619		27,619	42,430
101	0604798A	Brigade Analysis, Integration and Evaluation	05	191,065	99,947		99,947	105,279

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102	0604802A	Weapons and Munitions - Eng Dev	05	12,999	15,712		15,712	15,006
103	0604804A	Logistics and Engineer Equipment - Eng Dev	05	45,135	41,682		41,682	24,581
104	0604805A	Command, Control, Communications Systems - Eng Dev	05	18,543	7,376		7,376	4,433
105	0604807A	Medical Materiel/Medical Biological Defense Equipment - Eng Dev	05	38,712	39,447		39,447	30,397
106	0604808A	Landmine Warfare/Barrier - Eng Dev	05	37,769	92,236		92,236	57,705
107	0604814A	Artillery Munitions - EMD	05	3,576	8,205		8,205	
108	0604818A	Army Tactical Command & Control Hardware & Software	05	50,279	22,945		22,945	29,683
109	0604820A	Radar Development	05	3,734	1,548		1,548	5,224
110	0604822A	General Fund Enterprise Business System (GFEBS)	05	24,742	226		226	
111	0604823A	Firefinder	05	18,303	20,210		20,210	37,492
112	0604827A	Soldier Systems - Warrior Dem/Val	05	28,358	18,467		18,467	6,157
113	0604854A	Artillery Systems - EMD	05	149,667	121,270		121,270	1,912
114	0604869A	Patriot/MEADS Combined Aggregate Program (CAP)	05	348,234				
115	0604870A	Nuclear Arms Control Monitoring Sensor Network	05	7,093				
116	0605013A	Information Technology Development	05	44,684	68,778		68,778	69,761
117	0605018A	Integrated Personnel and Pay System-Army (IPPS-A)	05	122,168	69,253		69,253	138,465
118	0605028A	Armored Multi-Purpose Vehicle (AMPV)	05		28,285		28,285	92,353
119	0605030A	Joint Tactical Network Center (JTNC)	05		68,112		68,112	8,440
120	0605031A	Joint Tactical Network (JTN)	05					17,999
121	0605035A	Common Infrared Countermeasures (CIRCM)	05					145,409
122	0605350A	WIN-T Increment 3 - Full Networking	05					113,210

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123	0605380A	AMF Joint Tactical Radio System (JTRS)	05		10,213		10,213	6,882
124	0605450A	Joint Air-to-Ground Missile (JAGM)	05	9,686	15,119		15,119	83,838
125	0605456A	PAC-3/MSE Missile	05	63,123	68,807		68,807	35,009
126	0605457A	Army Integrated Air and Missile Defense (AIAMD)	05	247,407	369,452		369,452	142,584
127	0605625A	Manned Ground Vehicle	05	570,121	100,147		100,147	49,160
128	0605626A	Aerial Common Sensor	05	108,566	10,377		10,377	17,748
129	0605766A	National Capabilities Integration (MIP)	05		21,132		21,132	15,212
130	0605812A	Joint Light Tactical Vehicle (JLTV) Engineering and Manufacturing Development Ph	05	59,205	84,185		84,185	45,718
131	0605830A	Aviation Ground Support Equipment	05					10,041
132	0210609A	Paladin Integrated Management (PIM)	05					83,300
133	0303032A	TROJAN - RH12	05	3,892	3,463		3,463	983
134	0304270A	Electronic Warfare Development	05	12,828	10,801		10,801	8,961
		System Development & Demonstration		2,785,237	2,052,576	7,000	2,059,576	1,719,374
135	0604256A	Threat Simulator Development	06	16,409	23,921		23,921	18,062
136	0604258A	Target Systems Development	06	12,583	13,481		13,481	10,040
137	0604759A	Major T&E Investment	06	45,057	46,647		46,647	60,317
138	0605103A	Rand Arroyo Center	06	18,892	18,909		18,909	20,612
139	0605301A	Army Kwajalein Atoll	06	162,089	193,555		193,555	176,041
140	0605326A	Concepts Experimentation Program	06	24,720	22,246		22,246	19,439
141	0605502A	Small Business Innovative Research	06	169,555				
142	0605601A	Army Test Ranges and Facilities	06	334,087	340,477		340,477	275,025

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143	0605602A	Army Technical Test Instrumentation and Targets	06	61,711	66,025		66,025	45,596
144	0605604A	Survivability/Lethality Analysis	06	40,865	43,256		43,256	33,295
145	0605606A	Aircraft Certification	06	5,258	6,022		6,022	4,700
146	0605702A	Meteorological Support to RDT&E Activities	06	6,668	7,345		7,345	6,413
147	0605706A	Materiel Systems Analysis	06	18,622	19,799		19,799	20,746
148	0605709A	Exploitation of Foreign Items	06	5,501	5,938		5,938	7,015
149	0605712A	Support of Operational Testing	06	64,458	55,475		55,475	49,221
150	0605716A	Army Evaluation Center	06	57,037	65,240		65,240	55,039
151	0605718A	Army Modeling & Sim X-Cmd Collaboration & Integ	06	1,375	1,282		1,282	1,125
152	0605801A	Programwide Activities	06	75,662	81,993		81,993	64,169
153	0605803A	Technical Information Activities	06	48,995	33,835		33,835	32,319
154	0605805A	Munitions Standardization, Effectiveness and Safety	06	50,838	58,309		58,309	49,052
155	0605857A	Environmental Quality Technology Mgmt Support	06	4,276	5,191		5,191	2,612
156	0605898A	Management HQ - R&D	06	16,844	54,145		54,145	49,592
157	0909999A	Financing for Cancelled Account Adjustments	06	182				
		RDT&E Management Support		1,241,684	1,163,091		1,163,091	1,000,430
158	0603778A	MLRS Product Improvement Program	07	110,860	96,424		96,424	17,112
159	0607141A	Logistics Automation	07		3,715		3,715	3,654
160	0607664A	Biometric Enabling Capability (BEC)	07					1,332
161	0607865A	Patriot Product Improvement	07	44,581	35,034		35,034	152,991
162	0102419A	Aerostat Joint Project Office	07	142,508	83,406		83,406	54,076

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163	0203726A	Adv Field Artillery Tactical Data System	07	26,216	25,507		25,507	22,374
164	0203728A	Joint Automated Deep Operation Coordination System (JADOCs)	07					24,371
165	0203735A	Combat Vehicle Improvement Programs	07	189,396	177,437		177,437	295,177
166	0203740A	Maneuver Control System	07	60,948	36,475		36,475	45,092
167	0203744A	Aircraft Modifications/Product Improvement Programs	07	193,404	239,696		239,696	264,887
168	0203752A	Aircraft Engine Component Improvement Program	07	804	315		315	381
169	0203758A	Digitization	07	34,225	6,183		6,183	10,912
170	0203801A	Missile/Air Defense Product Improvement Program	07	17,863	1,577		1,577	5,115
171	0203802A	Other Missile Product Improvement Programs	07		62,067		62,067	49,848
172	0203808A	TRACTOR CARD	07	58,174	18,768		18,768	22,691
173	0205402A	Integrated Base Defense - Operational System Dev	07					4,364
174	0205410A	Materials Handling Equipment	07					834
175	0205412A	Environmental Quality Technology - Operational System Dev	07					280
176	0205456A	Lower Tier Air and Missile Defense (AMD) System	07					78,758
177	0205778A	Guided Multiple-Launch Rocket System (GMLRS)	07					45,377
178	0208053A	Joint Tactical Ground System	07	29,187	7,104		7,104	10,209
179	0208058A	Joint High Speed Vessel (JHSV)	07	32				
180	0301359A	Special Army Program	07					
181	0303028A	Security and Intelligence Activities	07	6,778	7,596		7,596	12,525
182	0303140A	Information Systems Security Program	07	14,314	9,351		9,351	14,175
183	0303141A	Global Combat Support System	07	108,506	41,203		41,203	4,527

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Department of the Army  
FY 2015 President's Budget  
Exhibit R-1 FY 2015 President's Budget  
Total Obligational Authority  
(Dollars in Thousands)

February 28, 2014

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

Line No	Program Element Number	Item	Act	FY 2013 (Base & OCO)	FY 2014 Base Enacted	FY 2014 OCO Enacted	FY 2014 Total Enacted	FY 2015 Base
184	0303142A	SATCOM Ground Environment (SPACE)	07	14,101	18,188		18,188	11,011
185	0303150A	WWMCCS/Global Command and Control System	07	13,208	14,208		14,208	2,151
186	0304348A	Advanced Geospatial Intelligence (AGI)	07					
187	0305204A	Tactical Unmanned Aerial Vehicles	07	28,466	33,515		33,515	22,870
188	0305208A	Distributed Common Ground/Surface Systems	07	38,673	27,607		27,607	20,155
189	0305219A	MQ-1C Gray Eagle UAS	07	68,694	10,895		10,895	46,472
190	0305232A	RQ-11 UAV	07	3,716	2,320		2,320	
191	0305233A	RQ-7 UAV	07	28,554	12,025		12,025	16,389
192	0307665A	Biometrics Enabled Intelligence	07	15,225	12,443		12,443	1,974
193	0310349A	Win-T Increment 2 - Initial Networking	07					3,249
194	0708045A	End Item Industrial Preparedness Activities	07	53,461	56,106		56,106	76,225
		Operational Systems Development		1,306,147	1,043,882		1,043,882	1,346,360
		Total Research, Development, Test & Eval, Army		8,010,810	7,122,681	13,500	7,136,181	6,593,898

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Army • Budget Estimates FY 2015 • RDT&E Program

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**Program Element Table of Contents (by Budget Activity then Line Item Number)..... ii**

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Army • Budget Estimates FY 2015 • RDT&E Program

Program Element Table of Contents (by Budget Activity then Line Item Number)

*Budget Activity 01: Basic Research*  
*Appropriation 2040: Research, Development, Test & Evaluation, Army*

.....

Line Item	Budget Activity	Program Element Number	Program Element Title	Page
1	01	0601101A	In-House Laboratory Independent Research.....	1
2	01	0601102A	DEFENSE RESEARCH SCIENCES.....	16
3	01	0601103A	University Research Initiatives.....	113
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Army • Budget Estimates FY 2015 • RDT&E Program

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

<b>Program Element Title</b>	<b>Program Element Number</b>	<b>Line Item</b>	<b>Budget Activity</b>	<b>Page</b>
DEFENSE RESEARCH SCIENCES	0601102A	2	01.....	16
In-House Laboratory Independent Research	0601101A	1	01.....	1
University Research Initiatives	0601103A	3	01.....	113
University and Industry Research Centers	0601104A	4	01.....	120

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<b>Exhibit R-2, RDT&amp;E Budget Item Justification:</b> PB 2015 Army	<b>Date:</b> March 2014
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<b>Appropriation/Budget Activity</b> 2040: <i>Research, Development, Test &amp; Evaluation, Army / BA 1: Basic Research</i>	<b>R-1 Program Element (Number/Name)</b> PE 0601101A / <i>In-House Laboratory Independent Research</i>
--	---

COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
Total Program Element	-	18.836	21.792	13.464	-	13.464	13.762	13.953	14.187	14.459	-	-
91A: <i>ILIR-AMC</i>	-	13.086	17.495	12.616	-	12.616	12.845	13.023	13.241	13.495	-	-
91C: <i>ILIR-Med R&amp;D Cmd</i>	-	3.689	2.885	-	-	-	-	-	-	-	-	-
91D: <i>ILIR-Corps Of Engr</i>	-	1.413	0.586	-	-	-	-	-	-	-	-	-
F16: <i>ILIR-SMDC</i>	-	0.648	0.826	0.848	-	0.848	0.917	0.930	0.946	0.964	-	-

# The FY 2015 OCO Request will be submitted at a later date.

**Note**

FY15 funding reduced to support higher Army priorities.

**A. Mission Description and Budget Item Justification**

This program element (PE) supports basic research at the Army laboratories through the In-House Laboratory Independent Research (ILIR) program. Basic research lays the foundation for future developmental efforts by identifying fundamental principles governing various phenomena and appropriate pathways to exploit this knowledge. The ILIR program serves as a catalyst for major technology breakthroughs by providing laboratory directors flexibility in implementing novel research ideas, by nurturing promising young scientists and engineers, and is used to attract and retain top doctoral degreed scientists and engineers. The ILIR program also provides a source of competitive funds for peer reviewed efforts at Army laboratories to stimulate high quality, innovative research with significant opportunity for payoff to Army warfighting capability.

This PE supports ILIR at the Army Materiel Command's (AMC) six Research, Development, and Engineering Centers (Project 91A); at the six U.S. Army Medical Research and Materiel Command Laboratories (Project 91C); the seven laboratories within the Corps Of Engineers' US Army Engineer Research and Development Centers (Project 91D); and at the Space and Missile Defense Command (SMDC) Technical Center (Project F16).

Work in the PE provides a foundation for applied research initiatives at the Army laboratories and research, development and engineering centers.

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 AMC, Aberdeen Proving Grounds, MD, and the SMDC, Huntsville, AL.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2015 Army				Date: March 2014	
Appropriation/Budget Activity 2040: Research, Development, Test & Evaluation, Army / BA 1: Basic Research		R-1 Program Element (Number/Name) PE 0601101A / In-House Laboratory Independent Research			
B. Program Change Summary (\$ in Millions)	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO	FY 2015 Total
Previous President's Budget	20.860	21.803	21.202	-	21.202
Current President's Budget	18.836	21.792	13.464	-	13.464
Total Adjustments	-2.024	-0.011	-7.738	-	-7.738
• Congressional General Reductions	-0.037	-0.011			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.434	-			
• Adjustments to Budget Years	-	-	-7.738	-	-7.738
• Other Adjustments 1	-1.553	-	-	-	-

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601101A / <i>In-House Laboratory Independent Research</i>				Project (Number/Name) 91A / <i>ILIR-AMC</i>			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
91A: <i>ILIR-AMC</i>	-	13.086	17.495	12.616	-	12.616	12.845	13.023	13.241	13.495	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
<b>Note</b> Not applicable for this item												
<b>A. Mission Description and Budget Item Justification</b> This project funds basic research within the Army Materiel Command's (AMC) Research, Development, and Engineering Centers and lays the foundation for future developmental efforts by identifying the fundamental principles governing various phenomena and appropriate pathways to exploit this knowledge.  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 Edgewood Chemical and Biological Center, Aberdeen Proving Grounds, MD within AMC, the Armaments Research, Development, and Engineering Center, Picatinny, NJ, the Tank and Automotive Research, Development, and Engineering Center, Warren, MI, the Natick Soldier Research, Development, and Engineering Center, Natick, MA, the Aviation and Missile Research, Development, and Engineering Center, Huntsville, AL, and the Communications and Electronics Research, Development, and Engineering Center, Ft. Monmouth, NJ.												
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>									FY 2013	FY 2014	FY 2015	
<b>Title:</b> Edgewood Chemical Biological Center									0.847	0.968	1.002	
<b>Description:</b> Funds basic research in chemistry, biology, biotechnology, and aerosol for counter improvised explosive devices (IEDs), obscurants, and/or target defeat.  Work in this project provides theoretical underpinnings for PE 0602622A (Chemical, Smoke, and Equipment Defeating Technologies).  <b>FY 2013 Accomplishments:</b> Conducted fundamental research to develop an understanding of: rational molecular and nano-system design; synthetic biology; nano-scale chemical and biological sensing and signaling; molecular toxicology; interfacial phenomena of particulate matter (solid/ liquid) with chemical surfaces; synthesis of new materials for protection, decontamination, and detection; and the mathematics involved in data processing and interpretation.  <b>FY 2014 Plans:</b>												

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014		
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601101A / <i>In-House Laboratory Independent Research</i>	Project (Number/Name) 91A / ILIR-AMC		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
Conduct fundamental research to develop an understanding of rational molecular and nano-system design, synthetic biology, nano-scale chemical and biological sensing and signaling, molecular toxicology, interfacial phenomena of particulate matter (solid/liquid) with chemical surfaces, and synthesis of new materials for protection, decontamination, and detection, as well as research the mathematics involved in data processing and interpretation.  <b>FY 2015 Plans:</b> Will conduct fundamental research to develop an understanding of rational molecular and nano-system design, synthetic biology, nano-scale chemical and biological sensing and signaling, molecular toxicology, interfacial phenomena of particulate matter (solid/liquid) with chemical surfaces, and synthesis of new materials for protection, decontamination, and detection, as well as research the mathematics involved in data processing and interpretation.				
<b>Title:</b> Armaments Research, Development and Engineering Center  <b>Description:</b> Funds basic research in weapons component development, explosives synthesis/detection and area denial.  Work in this project provides theoretical underpinnings for PE 0602307A (Advanced Weapons Technology).  <b>FY 2013 Accomplishments:</b> Continued to solicit on a yearly basis new efforts to further basic research in areas such as advanced materials and nanotechnologies, more powerful energetics including those with insensitive munition (IM) properties, counter terrorism technologies, power and energy systems, smaller more lethal warheads and composite materials.  <b>FY 2014 Plans:</b> Continue to solicit on a yearly basis new efforts to further basic research in areas such as advanced materials and nanotechnologies, more powerful energetics including those with insensitive munition (IM) properties, counter terrorism technologies, power and energy systems, smaller more lethal warheads and composite materials.  <b>FY 2015 Plans:</b> Will continue to solicit on a yearly basis new efforts to further basic research in areas such as advanced materials and nanotechnologies, more powerful energetics including those with insensitive munition (IM) properties, counter terrorism technologies, power and energy systems, smaller more lethal warheads and composite materials.		1.507	1.707	1.702
<b>Title:</b> Tank-Automotive Research, Development and Engineering Center  <b>Description:</b> Funds basic research in ground vehicle technologies to include power, mobility, and unmanned systems.  Work in this project provides theoretical underpinnings for PE 0602601A (Combat Vehicle and Automotive Technology).		1.171	1.220	1.502



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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014		
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601101A / <i>In-House Laboratory Independent Research</i>	Project (Number/Name) 91A / <i>ILIR-AMC</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
<p><b>FY 2013 Accomplishments:</b> Continued to research models for nanofluid coolants and lubricants. Researched functionally graded structures exposed to shock, will investigate statistical theories and algorithms for reliability based design optimization. Researched the combustion properties of JP-8, diesel and other fuels.</p> <p><b>FY 2014 Plans:</b> Research novel nanofluid coolants and lubricants; investigate statistical theories and algorithms for multi-disciplinary design optimization; research the combustion properties of new fuels; explore novel on-chip microwave nonreciprocal devices; research manned/unmanned teaming and cooperative mobility behaviors; and study electromagnetic wave reflection from nano-structured non-reciprocal metamaterials for non-reflective, cloak-type coatings.</p> <p><b>FY 2015 Plans:</b> Will investigate shock wave localization and propagation in layered media; will research the combustion properties of new fuels; will investigate discrete element modeling for granular terrain – vehicle interaction; will study on-wafer microwave nonreciprocal devices (isolators and circulators) based on artificial magnetic metamaterials and naturally anisotropic ferrite materials; will research manned/unmanned teaming and cooperative mobility behaviors; will research incremental learning for autonomous systems; and will research optical limiter techniques and materials for laser protection.</p>				
<p><b>Title:</b> Natick Soldier Research, Development and Engineering Center</p> <p><b>Description:</b> Funds basic research in food sciences, textiles, and lightweight materials with potential for individual protection.</p> <p>Work in this project provides theoretical underpinnings for PE 0601102A (Defense Research Sciences), Project H52 (Equipment for the Soldier).</p> <p><b>FY 2013 Accomplishments:</b> Developed novel biochemical functionalization strategies to tether bio-recognition elements and antibodies onto graphene; investigated covalent and non-covalent methods for attachment of antibodies to native graphene; measured physical and transport properties and demonstrated a functionalized Graphene Field Effect Transistor (FET) for analyte detection to identify visual information derived from the movements of individuals in crowds that specifies threatening or suspicious behaviors; validated experimental paradigms; continued experiments to refine the use of immersive virtual reality technologies for use with Soldier-volunteers.</p> <p><b>FY 2014 Plans:</b></p>		1.287	1.341	1.402

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014			
Appropriation/Budget Activity 2040 / 1		R-1 Program Element (Number/Name) PE 0601101A / <i>In-House Laboratory Independent Research</i>		Project (Number/Name) 91A / <i>ILIR-AMC</i>		
B. Accomplishments/Planned Programs (\$ in Millions)				FY 2013	FY 2014	FY 2015
Explore the unique physics of photonic nanomaterials for revolutionizing the performance and size of systems such as infrared (IR) detectors, power generation and remote imaging; continue to explore the relationship between peptide structure on tailored structures for controlling and optimizing the destructive efficacy of antimicrobial peptides for multiple applications.  <b>FY 2015 Plans:</b> Will explore the unique physics of photonic nanomaterials for revolutionizing the performance and size of systems such as infrared (IR) detectors, power generation and remote imaging; continue to explore the relationship between peptide structure on tailored structures for controlling and optimizing the destructive efficacy of antimicrobial peptides for multiple applications.						
<b>Title:</b> Aviation and Missile Research, Development and Engineering Center: Missile Efforts  <b>Description:</b> Funds basic research in guided missile and rocket systems, directed energy weapons, unmanned vehicles, and related components.  Work in this project provides theoretical underpinnings for PE 0602303A (Missile Technology).  <b>FY 2013 Accomplishments:</b> Experimentally explored infrared emissivity / absorptivity enhancement of polar materials by surface phonon coupling; analyzed nonlinear effects in nanostructure devices; experimentally investigated excitation.  <b>FY 2014 Plans:</b> Investigate paucity of attractors phenomenon in dynamical systems; develop theory of harmonic generation and Raman scattering from surfaces in nano-cavity environments; study optical propagation phenomena in the plasmonic regime in semiconductor and metal-based nanostructures and metamaterials; explore remote sensing of trace gases in the atmosphere using infrared/terahertz double resonance active interrogation; assess enhancement of infrared emissivity/absorptivity of polar materials near optical phonon resonances by surface phonon coupling and metamaterial effects.  <b>FY 2015 Plans:</b> : Will perform a pioneering demonstration of surface-enhanced analyte sensing and damage using plasmonic metal nanostructures; perform experimental test of analytic density matrix models in pump-probe spectroscopy; demonstrate chaotic dynamics in hybrid and non-smooth systems; pioneer innovative terahertz (THz) imaging techniques by combining state-of-the-art coherent imaging hardware and computational imaging methodologies; identify novel propagation phenomena that can dramatically modify/enhance linear and nonlinear interactions with artificial, metal-based plasmonic materials and semiconductors; perform an experimental study of plasmonic nanostructures in the enhanced transmission regime for applications to beam steering.				1.832	2.273	2.803
<b>Title:</b> Aviation and Missile Research, Development and Engineering Center: Aviation Efforts				1.422	1.647	1.602

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601101A / <i>In-House Laboratory Independent Research</i>	<b>Project (Number/Name)</b> 91A / <i>ILIR-AMC</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p><b>Description:</b> Funds basic research for aviation enabling technologies in the areas of aerodynamics, structural dynamics, and material science.</p> <p>Work in this project provides theoretical underpinnings for PE 0602211A (Aviation Technology).</p> <p><b>FY 2013 Accomplishments:</b> Completed initial testing on trailed wake vorticity and spanwise loading; completed Particle Image Velocimetry (PIV) data analysis for dynamic stall test case; and completed project on high advance ratio theory including all reporting.</p> <p><b>FY 2014 Plans:</b> Continue basic aerodynamic science research in the areas of vorticity dynamics, compressible dynamic stall, bluff body flow separation and flow physics; and investigate advanced boundary layer flow control phenomenon including fluidic oscillators and plasma devices.</p> <p><b>FY 2015 Plans:</b> Will continue basic fluid dynamic research in the areas of vorticity dynamics, unsteady flow separation, and flow control to identify fundamental governing principles; will complete analysis of wing/vortex interaction; will conduct detailed measurements of boundary layer response to flow control; and will continue work to increase control authority of plasma devices.</p>			
<p><b>Title:</b> Communications-Electronics Research, Development, and Engineering Center</p> <p><b>Description:</b> Funds basic research for communication and network enabling technologies in the areas of antenna design, network management, power generation and storage, and also sensors.</p> <p>Work in this project provides theoretical underpinnings for PE 0602705A (Electronics and Electronic Devices).</p> <p><b>FY 2013 Accomplishments:</b> Performed research in III-V component detector materials, advanced non-contact biometrics, nano engineered methods for explosive detection, and novel semiconductor growth processes and process monitoring; investigated novel electromagnetic polymer nanocomposites to gain a fundamental understanding of the underlying physics for potential antenna applications; continued investigations into alternative separator and electrolytes for high energy/power electrochemical couples by concentrating on reducing the parasitic (non-electrochemical) reactions between synthesized separator and electrolyte and high energy electrode components and initiated research into halogenated mixed metal oxides cathode material for advanced lithium electrochemical systems.</p> <p><b>FY 2014 Plans:</b></p>		1.314	2.509
			2.603

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014	
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601101A / <i>In-House Laboratory Independent Research</i>	Project (Number/Name) 91A / <i>ILIR-AMC</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
Conduct research into signals exploitation techniques by investigating algorithms for intelligently and rapidly searching wide bands of radio frequency (RF) spectrum for short duration signals by mathematically representing the shape of a specific RF signals; Research new algorithms based on mathematical models and new routing schemes for scalable and secure mobile ad hoc network (MANET)-based Real-Time Peer-to-Peer (P2P) Voice-over-IP (VoIP)/Multimedia Network; Synthesize and evaluate high energy cathode materials for application to electrochemical capacitors for increased energy density and longer cycle life; Investigate the feasibility of real-time, in-vacuo band edge thermometry for heteroepitaxy of II-VI thin films on semiconductor substrates for advanced IR detectors. Research the synthesis of dense Bismuth Selenide thin films, maximizing the material properties of conduction on the surface and insulating properties in the bulk, for use in RF front end electronics.  <b>FY 2015 Plans:</b> Will conduct research on a novel class of quasi-orthogonal waveforms that will allow radar systems to perform their primary target detection mission while simultaneously allowing data sharing with other systems; Will investigate a new compressive sensing approach to adaptive target detection, which can potentially ease antenna integration requirements for future multi-band/multi-aperture systems and improve the spatial resolution for target detection; Will investigate the fundamental distributed reformation reactions which affects species production, soot (coke) formation with more favorable reformed product gases; Will investigate the fundamental electrochemical properties of applied composite solid electrolyte interface for lithium electrochemical cells; Will investigate how Compressive Sensing (CS) affects image quality and develop metrics and model for CS; Will investigate how carrier transport phenomenology in epitaxial multilayer structures contribute to the performance of infrared focal plane arrays (FPAs); Will investigate graph anomaly detection to identify network intrusions using traffic flow graph analysis and anomaly detection.				
<b>Title:</b> Peer Reviewed Proposal Efforts  <b>Description:</b> Funds peer reviewed proposals in basic research to provide increased quality and responsiveness in exploring new technological concepts that are highly relevant to Army needs. This funding also enhances recruitment, development, and retention of outstanding scientists and engineers engaged in high quality basic research for the Army, which provides a constant flow of new knowledge to Army laboratories.  <b>FY 2013 Accomplishments:</b> Solicited new basic research efforts aimed at developing and maintaining a cadre of active research scientists who can distill and extend results from worldwide research in areas of interest to the Army.  <b>FY 2014 Plans:</b> Will solicit new basic research proposals aimed at developing and maintaining a cadre of active research scientists who can distill and extend results from worldwide research in areas of interest to the Army.		3.706	5.830	-
Accomplishments/Planned Programs Subtotals		13.086	17.495	12.616

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601101A / <i>In-House Laboratory Independent Research</i>	Project (Number/Name) 91A / <i>ILIR-AMC</i>
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A		
<b>Remarks</b>		
<b>D. Acquisition Strategy</b> N/A		
<b>E. Performance Metrics</b> N/A		

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601101A / <i>In-House Laboratory Independent Research</i>				Project (Number/Name) 91C / <i>ILIR-Med R&amp;D Cmd</i>			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
91C: <i>ILIR-Med R&amp;D Cmd</i>	-	3.689	2.885	-	-	-	-	-	-	-	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
A. Mission Description and Budget Item Justification												
This project fosters investigator-driven medical and force-health protection basic research initiatives performed at the six U.S. Army Medical Research and Materiel Command laboratories. Research areas address countermeasures against infectious diseases, defense against environmental extremes and operational hazards to health, mechanisms of combat trauma and innovative treatment and surgical procedures, and medical chemical/biological warfare threats.												
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 Walter Reed Army Institute of Research, Silver Spring, MD; U.S. Army Medical Research Institute of Chemical Defense, Aberdeen Proving Ground, MD; US Army Medical Research Institute of Infectious Diseases, Fort Detrick, MD; U.S. Army Institute of Environmental Medicine, Natick, MA; U.S. Army Institute of Surgical Research, Fort Sam Houston, TX; U.S. Aeromedical Research Laboratory, Fort Rucker, AL; and the Telemedicine and Advanced Technology Research Center, Fort Detrick, MD.												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2013	FY 2014	FY 2015	
Title: Independent Research Efforts									3.689	2.885	-	
Description: Funds basic research in medical and force health protection.												
FY 2013 Accomplishments: The program funded innovative in-house basic research proposals that focused on research to explore treatments and countermeasures against militarily relevant infectious diseases; defense against environmental extremes and operational hazards to health; mechanisms of combat trauma and innovative treatment and surgical procedures; and medical chemical/biological warfare threats. Examples of research efforts are as follows: Host and Wound Adaptations in <i>Acinetobacter baumannii</i> (a highly infectious bacteria) - this research enables novel methods to detect pathogens (germs) in the operating environment and predict their capacity to colonize or contaminate wounds in Soldiers and contaminate equipment to reduce infection with aggressive and drug resistant pathogens; explore the psychology of fear conditioning and learning to combat stimuli, to better understand psychopathology (causes of abnormal psychology) associated with combat experience; develop rodent models to study stress effects on brain cells, and use those models to identify nutritional measures conferring neuroprotection (brain protection) and resilience.												
FY 2014 Plans:												

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601101A / <i>In-House Laboratory Independent Research</i>	<b>Project (Number/Name)</b> 91C / <i>ILIR-Med R&amp;D Cmd</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
The program funds innovative in-house basic research proposals that will focus on research to explore treatments and countermeasures against militarily relevant infectious diseases; defense against environmental extremes and operational hazards to health; mechanisms of combat trauma and innovative treatment and surgical procedures; and medical chemical/biological warfare threats.			
<b>Accomplishments/Planned Programs Subtotals</b>		3.689	2.885
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601101A / In-House Laboratory Independent Research				Project (Number/Name) 91D / ILIR-Corps Of Engr			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
91D: ILIR-Corps Of Engr	-	1.413	0.586	-	-	-	-	-	-	-	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
Note Not applicable for this item												
A. Mission Description and Budget Item Justification												
This project funds In-house Laboratory Independent Research (ILIR) in the areas of geospatial research and engineering, military engineering, and environmental quality/installations at the seven laboratories within the Corps of Engineer's US Army Engineer Research and Development Center (ERDC).												
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 ERDC, Vicksburg, MS.												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2013	FY 2014	FY 2015	
Title: Geospatial Research and Engineering/Military Engineering/Environmental Quality and Installations									1.413	0.586	-	
Description: Funds basic research in the areas of geospatial research and military engineering as well as environmental quality and installations.												
FY 2013 Accomplishments: Created a numerical physics-based model of dynamic geologic-material contact behavior with buried sensors; created a methodology to rapidly characterize the near-ground atmospheric and instantaneous sound field between sensor nodes for a large region; compared experimental ground-penetrating radar data with models of the Maxwell Wagner process to understand if Maxwell Wagner processes are responsible for the variety of dielectric constants that appear in any soil at any water content.												
FY 2014 Plans: Quantify the fundamental coupling effects and transfer functions of fiber optic cable sensors inside of protective conduit within realistic and variable geologic media; determine parameters and build physics-based seismic propagation models for fiber, conduit, and geomaterial interaction.												
Accomplishments/Planned Programs Subtotals									1.413	0.586	-	



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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601101A / <i>In-House Laboratory Independent Research</i>	Project (Number/Name) 91D / <i>ILIR-Corps Of Engr</i>
C. Other Program Funding Summary (\$ in Millions) N/A		
Remarks		
D. Acquisition Strategy N/A		
E. Performance Metrics N/A		

# UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601101A / <i>In-House Laboratory Independent Research</i>				Project (Number/Name) F16 / <i>ILIR-SMDC</i>			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
F16: <i>ILIR-SMDC</i>	-	0.648	0.826	0.848	-	0.848	0.917	0.930	0.946	0.964	-	-

# The FY 2015 OCO Request will be submitted at a later date.

## A. Mission Description and Budget Item Justification

This project provides In-house Laboratory Independent Research (ILIR) at the US Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT), Technical Center. This basic research on lasers and directed energy lays the foundation for future developmental efforts on high energy lasers and directed energy systems by identifying the fundamental principles governing various directed energy phenomena.

Work in this project is related to, and fully coordinated with, efforts in PE 0602307A (Advanced Weapons 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 USASMDC/ARSTRAT, Technical Center, Huntsville, AL

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

	FY 2013	FY 2014	FY 2015
<b>Title:</b> SMDC In-house Laboratory Independent Research (ILIR)	0.648	0.826	0.848
<b>Description:</b> Funds basic research to investigate laser propagation phenomenology for application in modeling and simulation and future directed energy weapons design. Activities in this program transition to High Energy Laser Technology in PE 0602307A.			
<b>FY 2013 Accomplishments:</b> : Continued to conduct laser beam propagation experiments and spectroscopic research to improve modeling and simulation capabilities and improve high energy laser systems design.			
<b>FY 2014 Plans:</b> Complete laser beam propagation experiments and provide data for model anchoring. Continue spectroscopic research and improve modeling and simulation capabilities and begin design for flowing rare earth laser.			
<b>FY 2015 Plans:</b> Will demonstrate a diode pumped rare earth gas laser and begin assessing scalability and potential for very high efficiency operation; complete spectroscopy research on Xenon as a potential rare earth gas laser for transition to advanced beam control			

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601101A / <i>In-House Laboratory Independent Research</i>	<b>Project (Number/Name)</b> F16 / <i>ILIR-SMDC</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
efforts; complete 1.06 micron laser atmospheric propagation research for transition to solid state laser effects; and complete initial assessment of all-weather tracker phenomenology for transition to advanced beam control efforts.			
<b>Accomplishments/Planned Programs Subtotals</b>		0.648	0.826
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			

**UNCLASSIFIED**

Exhibit R-2, RDT&E Budget Item Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040: Research, Development, Test & Evaluation, Army / BA 1: Basic Research					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES							
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
Total Program Element	-	197.690	221.783	238.167	-	238.167	239.560	242.172	242.570	247.401	-	-
305: ATR Research	-	2.028	2.280	2.003	-	2.003	2.041	2.067	2.102	2.142	-	-
31B: Infrared Optics Rsch	-	2.621	2.859	3.307	-	3.307	2.860	2.896	2.942	2.999	-	-
52C: Mapping & Remote Sens	-	2.191	2.258	2.004	-	2.004	2.042	2.068	2.102	2.142	-	-
53A: Battlefield Env & Sig	-	3.302	3.570	2.610	-	2.610	3.777	3.824	3.889	3.964	-	-
74A: Human Engineering	-	7.576	8.409	14.614	-	14.614	13.411	13.422	13.051	11.066	-	-
74F: Pers Perf & Training	-	6.309	5.716	5.321	-	5.321	5.498	5.580	5.675	5.778	-	-
F20: Adv Propulsion Rsch	-	3.886	4.253	4.108	-	4.108	4.184	4.239	4.309	4.391	-	-
F22: Rsch In Veh Mobility	-	0.553	0.612	0.701	-	0.701	0.713	0.723	0.736	0.749	-	-
H42: Materials & Mechanics	-	7.865	8.902	9.308	-	9.308	8.662	8.784	8.933	9.098	-	-
H43: Research In Ballistics	-	8.299	9.378	8.810	-	8.810	8.462	8.579	8.722	8.886	-	-
H44: Adv Sensors Research	-	9.403	10.342	9.810	-	9.810	7.714	7.664	7.742	8.000	-	-
H45: Air Mobility	-	2.275	2.550	2.303	-	2.303	2.345	2.377	2.417	2.463	-	-
H47: Applied Physics Rsch	-	4.838	5.268	5.306	-	5.306	5.200	5.271	5.360	5.460	-	-
H48: Battlespace Info & Comm Rsc	-	19.563	21.545	25.320	-	25.320	25.633	25.821	25.662	23.909	-	-
H52: Equip For The Soldier	-	1.056	1.146	1.103	-	1.103	1.124	1.137	1.156	1.179	-	-
H57: Single Investigator Basic Research	-	69.342	80.342	81.245	-	81.245	87.862	89.077	88.046	93.767	-	-
H66: Adv Structures Rsch	-	1.853	2.017	2.006	-	2.006	2.044	2.068	2.102	2.142	-	-
H67: Environmental Research	-	0.935	1.030	0.903	-	0.903	0.920	0.931	0.946	0.965	-	-
S13: Sci BS/Med Rsh Inf Dis	-	11.172	10.696	11.005	-	11.005	11.248	11.378	11.560	11.789	-	-
S14: Sci BS/Cbt Cas Care Rs	-	8.794	9.167	10.553	-	10.553	9.827	9.970	10.141	10.325	-	-
S15: Sci BS/Army Op Med Rsh	-	5.013	7.366	6.815	-	6.815	6.636	6.720	6.831	6.961	-	-
T22: Soil & Rock Mech	-	3.951	4.577	5.704	-	5.704	4.484	4.548	4.624	4.710	-	-
T23: Basic Res Mil Const	-	1.618	1.772	2.102	-	2.102	1.733	1.757	1.787	1.820	-	-

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Exhibit R-2, RDT&E Budget Item Justification: PB 2015 Army										Date: March 2014			
Appropriation/Budget Activity					R-1 Program Element (Number/Name)								
2040: Research, Development, Test & Evaluation, Army / BA 1: Basic Research					PE 0601102A / DEFENSE RESEARCH SCIENCES								
T24: Signature Physics And Terrain State Basic Research	-	1.424	1.600	2.005	-	2.005	1.635	1.655	1.681	1.715	-	-	
T25: Environmental Science Basic Research	-	5.620	7.171	7.303	-	7.303	7.028	7.129	7.251	7.385	-	-	
T63: Robotics Autonomy, Manipulation, & Portability Rsh	-	1.760	1.990	7.000	-	7.000	7.286	7.218	7.443	8.140	-	-	
T64: Sci BS/System Biology And Network Science	-	2.726	2.958	2.398	-	2.398	2.952	2.996	3.048	3.102	-	-	
VR9: Surface Science Research	-	1.717	2.009	2.500	-	2.500	2.239	2.273	2.312	2.354	-	-	
# The FY 2015 OCO Request will be submitted at a later date.													
<b>Note</b>													
FY 13 decreases attributed to Congressional General Reductions (-397 thousand); SBIR/STTR transfers (-4.168 million) and Sequestration Reductions (-16.925 million)													
<b>A. Mission Description and Budget Item Justification</b>													
This program element (PE) builds fundamental scientific knowledge contributing to the sustainment of US Army scientific and technological superiority in land warfighting capability and to solving military problems related to long-term national security needs, investigates new concepts and technologies for the Army's future force, and provides the means to exploit scientific breakthroughs and avoid technological surprises. This PE fosters innovation in Army niche areas (such as lightweight armor, energetic materials, night vision capability) and areas where there is no commercial investment due to limited markets (e.g., vaccines for tropical diseases). It also focuses university single investigator research on areas of high interest to the Army (e.g., high-density compact power and novel sensor phenomenologies). The in-house portion of the program capitalizes on the Army's scientific talent and specialized facilities to transition knowledge and technology into appropriate developmental activities. The extramural program leverages the research efforts of other government agencies, academia, and industry.													
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 PE is performed by: the U.S. Army Research Laboratory (ARL), Adelphi, MD; the U.S. Research, Development and Engineering Command (RDECOM), Aberdeen, MD; the U.S. Army Medical Research and Materiel Command (MRMC), Ft. Detrick, MD; the U.S. Army Engineer Research and Development Center (ERDC), Vicksburg, MS; and the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI), Arlington, VA.													

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Exhibit R-2, RDT&E Budget Item Justification: PB 2015 Army				Date: March 2014	
Appropriation/Budget Activity 2040: Research, Development, Test & Evaluation, Army / BA 1: Basic Research		R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES			
B. Program Change Summary (\$ in Millions)	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO	FY 2015 Total
Previous President's Budget	219.180	221.901	224.167	-	224.167
Current President's Budget	197.690	221.783	238.167	-	238.167
Total Adjustments	-21.490	-0.118	14.000	-	14.000
• Congressional General Reductions	-0.397	-0.118			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-4.168	-			
• Adjustments to Budget Years	-	-	14.000	-	14.000
• Other Adjustments 1	-16.925	-	-	-	-

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) 305 / ATR Research			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
305: ATR Research	-	2.028	2.280	2.003	-	2.003	2.041	2.067	2.102	2.142	-	-

# The FY 2015 OCO Request will be submitted at a later date.

## A. Mission Description and Budget Item Justification

This project fosters research for automatic target recognition (ATR) concepts to enhance the effectiveness of Army systems while simultaneously reducing the workload on the Soldier. This project focuses on the fundamental underpinnings of aided and unaided target detection and identification techniques for land warfare scenarios including tagging, tracking, and locating (TTL) of non-traditional targets. This research enables Army systems that can act independently of the human operator to detect and track targets including clandestine tracking of non-cooperative targets. Such capabilities are needed for smart munitions, unattended ground sensors, and as replacements for existing systems. Critical technology issues include low depression angle, relatively short range, and highly competing background clutter. The resulting research will provide a fundamental capability to predict, explain, and characterize target and background signature content, and reduce the workload on the analyst. This research is aimed at determining the complexity and variability of target and clutter signatures and ultimately utilizing that knowledge to conceptualize and design advanced ATR paradigms to enhance robustness and effectiveness of land warfare systems. ATR research strategies include emerging sensor modalities such as spectral and multi-sensor imaging. Research in this project builds knowledge for several technology efforts including multi-domain smart sensors, third generation Forward Looking Infrared (FLIR), and advanced multi-function laser radar (LADAR).

Work in this project complements and is fully coordinated with the U.S. Army Armaments Research, Development, and Engineering Center (ARDEC); the U.S. Army Communications-Electronics Research, Development, and Engineering Center (CERDEC); and the U.S. Army Edgewood Chemical Biological Center (ECBC).

Work in this project supports key Army needs and provides the technical underpinnings to several Program Elements (PEs) to include PE 0606270A (Electronic Warfare Technology)/Project 906 (Tactical Electronic Warfare Applied Research).

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), Adelphi, MD.

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

	<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>
<b>Title:</b> ATR Algorithms	1.229	1.338	1.218
<b>Description:</b> Investigate new algorithms to improve aided/unaided target detection and identification.			
<b>FY 2013 Accomplishments:</b>			

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> 305 / ATR Research	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
Investigated methods for object and event detection and classification using multimodal and hyperspectral imaging sensors to support Data-to-Decision capabilities; and conducted research for optimal sensor fusion and novel feature selection techniques to enhance Automatic Target.			
<b>FY 2014 Plans:</b> Investigate methods for human detection, cross-modality face recognition, and robust spectral signature analysis to enhance Data-to-Decision capabilities; and develop ATR algorithms insensitive to signature variations and environmental changes.			
<b>FY 2015 Plans:</b> Will investigate methods for automatic human and vehicle activity detection and classification, and multimodal biometrics for improved situational understanding and reduced soldier workload; research methods to select relevant data for enhanced decision making; and develop machine learning algorithms for scene understanding.			
<b>Title:</b> Tagging, Tracking and Locating (TTL)		0.799	0.942
<b>Description:</b> Conduct basic research to support advances in state-of-the-art clandestine (Transistor-transistor logic) TTL for non-traditional hostile force and non-cooperative targets. Specific technical objectives, products, and deliverables are in accordance with the Hostile Forces TTL Capabilities Development Document and the TTL Science and Technology Roadmap. This effort directly supports the U.S. ARL's efforts in applied research and the U.S. Army CERDEC's advanced research in clandestine TTL.			0.785
<b>FY 2013 Accomplishments:</b> Investigated and designed advanced algorithms, components, sensors, and techniques applicable to Transistor-transistor logic (TTL); assessed the use of inherent target signatures including hyperspectral signatures to provide enhanced TTL standoff capabilities; further investigated the application of nanotechnology and microelectromechanical systems (MEMS) to TTL technologies; examined advanced technologies across the electromagnetic spectrum including ultraviolet, infrared, and radio frequency for enhanced range performance and covertness; and advanced flexible electronics and non-cooperative biometric identification for TTL applications.			
<b>FY 2014 Plans:</b> Develop multimodal methods to monitor, extract and disseminate information related to targets' changing characteristics and the means to influence target behavior to create measurable signatures of interest; and develop (from the hyperspectral data assessment made in FY13) more effective methods for autonomous, non-motion based, motor-vehicle tracking by fusing proven detection/classification techniques for different applications (e.g. hyperspectral target detection, speech recognition) to provide enhanced TTL standoff capabilities.			
<b>FY 2015 Plans:</b>			



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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> 305 / ATR Research	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
Will investigate methods for robust location and tracking of vehicles in surveillance and wide area motion images in the presence of occlusions using augmented three-dimensional terrain maps; investigate virtual tags for tracking humans using hyperspectral signatures; and investigate electromagnetic sensor and processing techniques to extract target characteristics from new signatures and exploit vulnerabilities.			
<b>Accomplishments/Planned Programs Subtotals</b>		2.028	2.280
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			

# UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) 31B / Infrared Optics Rsch			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
31B: Infrared Optics Rsch	-	2.621	2.859	3.307	-	3.307	2.860	2.896	2.942	2.999	-	-

# The FY 2015 OCO Request will be submitted at a later date.

## Note

Not applicable for this item.

## A. Mission Description and Budget Item Justification

This project supports Army research in materials and devices for active and passive infrared (IR) imaging systems; radio frequency (RF) photonics for radar, communications, and electronic warfare applications; and laser technology for missile threat countermeasure protection. This research aims to generate new technologies for unprecedented battlefield situational awareness and to continue the dominance of Army units during night operations. To achieve these objectives, IR focal plane arrays (FPAs) and lasers with significantly improved performance, lower cost, and increased operating temperatures are required. This research has direct application to Army ground vehicles, aviation platforms, weapon systems, and the individual Soldier. Research is focused on material growth, detector and laser design, and processing for large area multicolor IR FPAs and midwavelength IR lasers. The principal efforts are directed towards novel materials for detectors and lasers, and investigating energy band-gap structures in semiconductor materials to enhance the performance of lasers and IR FPAs. In the area of RF Photonics, near-IR modeling and nanofabrication techniques are applied to the design and fabrication of IR photonic-crystal waveguide structures having customized IR properties. This research also is intended to lay the foundation for the development of integrated optoelectronic circuits using active and passive devices and components such as lasers, waveguides, and detectors in conjunction with fiber optic interconnects for the generation, distribution, processing, and control of microwaves and study the fundamental physics of signal processing and noise generation as well as the conversion between the time and frequency domains and the optical and electrical domains in these opto-electronic (OE) circuits/systems. The technical goals are to manage and control defects in the raw, unprocessed materials, maintaining quality control in the fabrication of the devices and arrays, limiting introduction of impurities in the material, surface passivation of the devices so that they are resistant to degradation over time and thermal management, particularly as it applies to interband cascade lasers. This work is coordinated with the U.S. Army Communications Electronics Research, Development, and Engineering Center (CERDEC).

Work in this project supports key Army needs and provides the technical underpinning to several Program Elements (PEs) to include PE 0602709A (Night Vision Technology)/Project H95 (Night Vision and Electro-Optic Technology).

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

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

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> 31B / Infrared Optics Rsch	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p><b>Title:</b> Electro-Optic Materials Research, RF Photonics for Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance(C4ISR), and Photonics Research for Electronic Warfare</p> <p><b>Description:</b> Conduct research into infrared focal plane arrays (IR FPAs), radio-frequency (RF) Photonics, and IR countermeasures to increase situational awareness in open and complex terrain; improve target detection, identification, and discrimination; and enhance missile threat IR countermeasure (IRCM) protection.</p> <p><b>FY 2013 Accomplishments:</b> Advanced investigations of environmental effects on radio-frequency (RF) photonic devices and reduced their vibration and temperature sensitivity for improved reliability; experimentally validated the RF-photonic time domain signal auto-correlation processor for signals intelligence applications; developed nano-photonic devices and nano-fabrication techniques for chip-scale opto-electronic integrated circuit devices with reduced size, weight and power; investigated plasmonic materials, metamaterials, photonic crystals and resonating materials on the quantum efficiency of Quantum Well Infrared Photodetectors (QWIPS); extended the operating wavelength of III-V semiconductor devices, explore materials properties for the Type II Strained Layer Superlattice and investigate novel growth approaches and novel growth structures that will result in cheaper IR FPAs; and investigated possible methods of improving power output of quantum cascade lasers with potential transition to infrared countermeasures applications.</p> <p><b>FY 2014 Plans:</b> Research advanced radio-frequency (RF)-photonic/optical techniques to study noise generation and mitigation in RF-over fiber links to achieve ultra high resolution, wideband signal transmission; investigate long-wave infrared (LWIR) two-color IR detectors using combinations of bulk materials and artificially layered structures, taking advantage of low cost materials and novel insights in materials properties; establish a 3-dimensional, finite element electromagnetic model to calculate quantum efficiency (QE) for any infrared detector structures; design novel semiconductor metastructure photonic devices to provide the basic building blocks for future chip scale processing; investigate frontier optical effects to design high QE detectors;and improve power output of quantum cascade lasers.</p> <p><b>FY 2015 Plans:</b> Will grow and characterize new long-wave infrared (LWIR) bulk semiconductor materials used in new detector designs with potential for low-cost, high performance applications; investigate the physical limitations in a variety of RF-Photonic signal generation, transport, and processing schemes to optimize system resolution and bandwidth for C4ISR applications (e.g., position, navigation, and timing applications) that require very high phase precision; investigate optical and physical properties of novel semiconductor metamaterial and metastructure devices for applications such as chip scale chem/bio sensors and lighter and</p>		2.621	2.859
			3.307

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014		
<b>Appropriation/Budget Activity</b> 2040 / 1		<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES		<b>Project (Number/Name)</b> 31B / Infrared Optics Rsch
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>
cheaper radios; and study electro-optical (EO) modulator based on nano-crystal silicon for next generation high speed chip scale communication.				
<b>Accomplishments/Planned Programs Subtotals</b>		2.621	2.859	3.307
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A				
<b>Remarks</b>				
<b>D. Acquisition Strategy</b> N/A				
<b>E. Performance Metrics</b> N/A				

# UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) 52C / Mapping & Remote Sens			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
52C: Mapping & Remote Sens	-	2.191	2.258	2.004	-	2.004	2.042	2.068	2.102	2.142	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
Note Not applicable to this item												
A. Mission Description and Budget Item Justification												
This project increases knowledge of terrain with a focus on improving the generation, management, analysis/reasoning, and modeling of geospatial data, and the exploitation of multi-sensor data. This fundamental knowledge forms the scientific "springboard" for the future development of applications, techniques, and tools to improve the tactical commander's knowledge of the battlefield. Results of this research are used to extract and characterize natural and man-made features from reconnaissance imagery in near-real time; to exploit terrain analysis and reasoning techniques; and to explore the potential of space technology and tactical geospatial sensor technology to provide real-time terrain intelligence, command and control, and targeting support. This research uses terrain and environmental data to improve situational awareness and enhance information dominance, leading to increased survivability, lethality, and mobility.												
Work in this project provides theoretical underpinnings for PE 0602784A (Military Engineering Technology), Project 855 (Mapping and Remote Sensing).												
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 Engineer Research and Development Center (ERDC), Vicksburg, MS.												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2013	FY 2014	FY 2015	
Title: Sensor Phenomenology and Spatial-Temporal Pattern Discovery									2.191	2.258	2.004	
Description: Funding provided for the following research.												
FY 2013 Accomplishments: Investigated a multi-parameter soil metabolic index to understand environmental impacts on emerging biological sensing; constructed primitives to aid in efficiently solving concurrent complex queries in hierarchically represented spatial-temporal data; validated new infrasound signal propagation models against collected data applicable to remote assessment of hostile activity.												
FY 2014 Plans: Investigate and define the concepts of neighborhood and scale for human terrain parameters, and examine clustering and topology in human terrain neighborhoods to understand how human terrain events propagate through Euclidean and social												

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> 52C / Mapping & Remote Sens	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
network space; investigate methodologies for transforming multi-dimensional spatial-temporal trajectory data into linear representation for discovering patterns and hierarchical structure; investigate approaches to estimating terrain physical properties from proprioceptive sensor data.			
<b>FY 2015 Plans:</b> Will investigate aerosol effects on the integrity of Light Detection and Ranging (LiDAR) signals to improve signal and data collection capabilities; will explore methods of describing objects in massive unstructured datasets through novel machine learning techniques to advance Big Data capabilities; will investigate multi-source signal decomposition and characterization from single acoustic sensors to increase monitoring capabilities; will theorize metrics for the quantification of adaptive capacity of human populations resulting from environmental change to monitor instability.			
<b>Accomplishments/Planned Programs Subtotals</b>		2.191	2.258
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b> N/A			
<b>E. Performance Metrics</b> N/A			

# UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) 53A / Battlefield Env & Sig			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
53A: Battlefield Env & Sig	-	3.302	3.570	2.610	-	2.610	3.777	3.824	3.889	3.964	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
Note Not applicable for this item												
A. Mission Description and Budget Item Justification												
This project focuses on research to seek an in-depth understanding of the complex atmospheric boundary layer associated with high-resolution meteorology; the transport, dispersion, optical properties and characterization of chemical and biological aerosols; and the propagation of full-spectrum electro-magnetic and acoustic energy. The future Army will operate in very complex environments (e.g., urban, mountainous, forested and jungle terrain) requiring new approaches to understand, characterize, and depict environmental phenomena and their effects on military systems, personnel and operations. The lack of a complete understanding of the meteorological aspects of the complex microscale boundary layer in which the Army operates continues to impact our ability to provide predictable, actionable, accurate and timely tactical environmental intelligence to battlefield commanders and small Soldier units. This project focuses on producing the foundational environmental science research to characterize the atmospheric boundary layer and deliver novel capabilities and techniques including urban turbulence characterization for its effects on micro platforms and sensor payloads, high resolution urban wind flow modeling for more efficient and accurate prediction of the transport and dispersion of obscurants and chemicals, battlefield aerosol characterization and the interaction between aerosols and meteorological processes for Soldier health initiatives, characterization and detection of bio-warfare agent aerosols, environmental effects on acoustic and electromagnetic signal propagation in urban and other complex domains for improved target location and imaging, exploration of previously unexploited regions of the acoustic and electro-magnetic spectrum, and formulation of objective analysis tools that can assimilate on-scene all-source weather observations, atmospheric composition, and fuse this information with forecasts to provide immediate Nowcast products and actionable information. These capabilities will have a direct impact on ensuring Soldier survivability, weapon system lethality, effective surveillance and reconnaissance, and the mobility required for future warfighter mission planning and execution operations.												
Work in this project supports key Army needs and provides the theoretical underpinnings for Program Element (PE) 0602784A (Military Engineering Technology)/Project H71 (Meteorological Research for Battle Command).												
The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.												
Work in this project is performed by the Army Research Laboratory (ARL), Adelphi, MD & White Sands Missile Range, NM.												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2013	FY 2014	FY 2015	
Title: Research in optical and acoustical propagation in the atmosphere									1.937	2.110	-	

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014		
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES	Project (Number/Name) 53A / Battlefield Env & Sig		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
<p><b>Description:</b> Research in optical and acoustical propagation in the atmosphere for enhanced Intelligence, Surveillance, and Reconnaissance capabilities for the future force to support situational understanding and rapid targeting.</p> <p><b>FY 2013 Accomplishments:</b> Investigated how bioaerosol properties change with different atmospheric conditions (sunlight, humidity, oxidizing agents, etc.) so that these properties can be added to transport and dispersion models for force protection and mission planning; measured fluorescence and absorption cross sections of aerosolized bio-warfare simulants/agents to enable more accurate assessments of the capabilities of biowarfare agent detectors; investigated Raman spectra of individual airborne bioparticles to provide increased capability for characterizing atmospheric particles; established functional relationships between mid-infrared (MidIR) and long-wave infrared (LWIR) polarimetric signatures as a function of atmospheric and meteorological conditions for improved target detection, classification, and identification; extended terahertz (THz) propagation modeling to include path radiance and water vapor background noise to add these performance effects and improve the design of emerging passive THz imaging technology; and improved the fundamental theory for optical turbulence effects on short-exposure passive electro-optics and infrared imaging for new optimal designs for passive adaptive optics correction.</p> <p><b>FY 2014 Plans:</b> Investigate and model atmospheric water vapor impacts on THz band communications propagation statistics for digital link quality for U.S. Army Aviation and Missile Research, Development and Engineering Command (AMRDEC) covert local wireless communications technology applications. Measure and model optical turbulence to improve the prediction of strong turbulence effects on high energy laser propagation in complex terrain.</p>				
<p><b>Title:</b> Predictive Modeling of the Boundary Layer</p> <p><b>Description:</b> Increase survivability and improve situational awareness for a variety of sensors, optics and flying objects (projectiles, unmanned aircraft systems, etc.) through research to enhance accuracy of predictive modeling of the atmospheric boundary layer and improve the ability to function effectively in adverse conditions.</p> <p><b>FY 2013 Accomplishments:</b> Enhanced the three dimensional (3-D) Atmospheric Boundary Layer Environment (ABLE) model's turbulence parameterizations to extend modeling of high resolution dynamic turbulent flow effects of complex terrain to improve urban hazard dispersion and wind effects on robotic air vehicles; improved characterization and simulation of urban turbulence effects and bio-inspired control corrections that will improve Nano and Micro Air Vehicle control, hover stability and wind gust rejection; and investigated using Weather Research &amp; Forecasting-based Weather Running Estimate-Nowcast (WRE-N) forecast/local now-cast model output as</p>		1.365	1.460	2.610



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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> 53A / Battlefield Env & Sig	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p>initial conditions to improve the fidelity and accuracy of predictions from the boundary layer 3-D ABLE model for high resolution meteorology in complex terrain.</p> <p><b>FY 2014 Plans:</b> Formulate and evaluate numerical methods to improve ABLE model performance for Army decision aid applications; investigate biologically-inspired fast patterned responses to control surface wind flow changes to more effectively predict and mitigate boundary layer wind gust effects on micro air vehicle hover and stability; and investigate and develop an experimental hybrid data assimilation approach to improve fine-scale weather forecast performance.</p> <p><b>FY 2015 Plans:</b> Will finalize and implement an experimental hybrid data assimilation approach into microscale and mesoscale numerical weather prediction models to improve fine-scale weather forecast performance; research options for implementing a computationally efficient WRE-N model to produce localized probabilistic forecast grids suitable for tactically-deployed unit hosting; explore novel approaches for developing an agile feedback loop that incorporates model-driven sensing and collection, and uses boundary layer sensing for near real-time model adaptation and corrected predictions; and determine feasibility of atmospheric energy harvesting for small scale applications.</p>			
<b>Accomplishments/Planned Programs Subtotals</b>		3.302	3.570
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) 74A / Human Engineering			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
74A: Human Engineering	-	7.576	8.409	14.614	-	14.614	13.411	13.422	13.051	11.066	-	-

# The FY 2015 OCO Request will be submitted at a later date.

**Note**  
Not applicable for this item

**A. Mission Description and Budget Item Justification**  
This project focuses on research that improves Soldier-system performance in future force environments by looking at key phenomena underlying Soldier performance such as auditory spatial orientation (perception of azimuth, elevation and distance of sounds) within uncertain, degraded acoustic conditions; extending and protecting auditory and cognitive performance; human performance in automated, mixed-initiative (human control-machine control) environments; communications in hearing-degraded conditions; visual scanning and target detection; Soldier emotion and fatigue states; integration across multiple sensory modalities; perceptual-motor behavior; collaborative (team) and independent multi-task, multi-modal, multi-echelon Soldier-system performance - all cast against the influx of emerging transformation-driven technological solutions and opportunities. Technical barriers include lack of methods for describing, measuring, and managing the interplay of these relatively novel phenomena due to situational complexity and ambiguity that characterize operations in the future force. Technical solutions are being pursued in the areas of data generation and algorithm development in these emerging environments in order to update and improve our understanding of performance boundaries and requirements and enable neuroengineering. These solutions include multi-disciplinary partnerships, metrics, simulation capabilities, and modeling tools for characterizing Soldier-system performance, and provide a shared conceptual and operational framework for militarily relevant research on cognitive and perceptual processes. In the area of translational neuroscience, which is the transition of basic neuroscience research to relevant applications, research is carried out to examine leading edge methodologies and technologies to improve the measurement and classification of neural states and behavior in operationally-relevant environments, to examine the potential application of neuroscience theories to autonomous systems to improve Soldier-system interactions, to model the relationship between brain structure and cognitive performance for understanding individual differences and injury, and to assess how neural pathways implicated in functional processing can be enhanced through dynamic system interface technologies for improving in-theatre performance and training.

Work in this project supports key Army needs and provides the technical underpinnings to several PEs to include PEs 0601104A (University and Industry Research Centers)/Project H09 (Robotics Collaborative Technology Alliance) and 0602716A (Human Factors Engineering Technology)/H70 (Human Factors Engineering System Development).

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), Human Research and Engineering Directorate, Aberdeen Proving Ground, MD.

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014		
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / <i>DEFENSE RESEARCH SCIENCES</i>	<b>Project (Number/Name)</b> 74A / <i>Human Engineering</i>		
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>
<b>Title:</b> Research to Characterize and Enhance Soldier Performance  <b>Description:</b> Characterize and enhance human auditory performance of the dismounted warrior in complex environments while protecting the hearing of the Soldier.  <b>FY 2013 Accomplishments:</b> Investigated the sound characteristics of weapon firing signatures to enable Soldiers' future ability to identify the specific weapons being fired and location of attack.  <b>FY 2014 Plans:</b> Quantify the effects of compression type on relative distance perception when wearing tactical communication and protection systems (TCAPS).  <b>FY 2015 Plans:</b> Will conduct Soldier-oriented research to understand the auditory conditions that lead to misinterpretation of auditory events in a complex sensory environment; quantify and describe spatial range across which detection of auditory location changes are unlikely to be detected; and characterize the environmental elements and contexts that may be vulnerable to misinterpretation.		2.022	2.025	2.883
<b>Title:</b> Soldier performance  <b>Description:</b> Conduct fundamental research on human performance in military-relevant environments to include operations, command, and training. Use approaches such as computational cognitive modeling and social network analyses to investigate the factors affecting the information flow, situational understanding and prediction, and technology-mediated collaboration under conditions of stress and uncertainty. Determine the environmental and context factors affecting performance, learning, and retention in immersive and simulated environments; establish realism/fidelity boundary conditions for perceptual, cognitive, and physical parameters for experimentation and for training.  <b>FY 2013 Accomplishments:</b> Continued to transition cognitive model-based architecture knowledge for robotics control to the Robotics Collaborative Technology Alliance (PE 0601104/project H09) and the ARL Robotics enterprise; developed a generic long-term memory capability to store collections of environmental data sets; advanced object recognition and tracking; and switched focus of research on the correlation of electroencephalograph data with response times to decision making studies, which will further the validation of higher-level components of the Adaptive Control of Thought-Rational (ACT-R) cognitive modeling system.  <b>FY 2014 Plans:</b> Enhance recognition of places and objects for the Symbolic and Sub-symbolic Robotics Intelligence Control System project by integrating multiple independent cues for perpetual processing to include contextual processing, depth processing, and color		1.881	2.656	2.531

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army			<b>Date:</b> March 2014		
<b>Appropriation/Budget Activity</b> 2040 / 1		<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES		<b>Project (Number/Name)</b> 74A / Human Engineering	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>			<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>
processing; perform engineering evaluation tests of key autonomous robotic functions for navigation, object recognition, short- and long-term memory, and understanding and acting on verbal operator commands through natural language processing; expand the project on temporal network dynamics for the social-cognitive network science initiative by identifying specific behaviors of complex dynamical systems (i.e., networks) and implementing techniques for capturing those behaviors using an enhanced version of the computer model Command, Control and Communications Technologies for Reliable Assessment of Concept Execution (C3TRACE), which will allow development of a "network sandbox"; and conduct research investigating the effects of operationally relevant stressors on Soldier performance during tactical operations (for the cognitive readiness initiative).					
<b>FY 2015 Plans:</b> Will further the development of human performance information processing models addressing network challenges using formal mathematical approaches and task-network modeling and simulation to integrate information across network layers for better information management and planning; establish a theoretical foundation for human networking behavior yielding testable predictions for laboratory experiments (modeling effort); continue the development of object recognition of places and objects (cognitively-inspired intelligent robotic technology); leverage the results of industry efforts in shape recognition features; conduct experiments in realistic contexts with human interaction; conduct experiments to fill data voids and develop models describing and able to predict the key simulation parameters affecting perception, cognition, and physical performance independently (simulation and training); and outline experimentation required to determine simulation parameters affecting the interactions across perception, cognition, and physical performance.					
<b>Title:</b> Translational Neuroscience  <b>Description:</b> Integrating neuroscience with traditional approaches to understanding Soldier behavior to enable systems designs that maximize Soldier performance.  <b>FY 2013 Accomplishments:</b> Investigated sensory and motor neural processes with respect to effect on Soldier-systems within dynamic environments; examined validation techniques for measures of task performance in operational environments to develop future Soldier metrics; and evaluated efficacy of predictive metrics for neural processing and/or cognitive performance among individuals for quantifying cognitive loads.  <b>FY 2014 Plans:</b> Enhance neuroimaging technologies for increased resolution, greater wearability by Soldiers, and enhanced interpretability of neural signatures in realistic environments; and investigate the relationships between neuromodulators, brain electrical activity, and behavior for improved understanding of Soldier neurocognitive function.  <b>FY 2015 Plans:</b>			2.412	2.455	4.200

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> 74A / Human Engineering	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
Will develop and refine active machine learning algorithms for improving the task performance of brain-based technologies that combine neural signals extracted from the Soldier with semi-autonomous computer systems; examine effects of environmental context on cognitive brain state assessments; explore analytical approaches for interpreting brain activity in unstructured tasks; and investigate how different signal processing approaches affect the detection of brain network signal estimates in order to support future development of brain-based technologies.			
<b>Title:</b> Cognition and Neuroergonomics  <b>Description:</b> Devise and show fundamental translational principles for neuroscience-based research and theory to complex operations settings in three focus areas: Soldier-system information transfer, commander-level decision making, and individualized analysis and assessment of cognitive performance in operational environments. Beginning in FY15, will be incorporated into Translational Neuroscience.  <b>FY 2013 Accomplishments:</b> Explored neural representations and developed novel measures for assessing individual differences in decision making, cognitive performance, and/or anatomical structure; and explored network connectivity measures and patterns in both model simulations and empirical datasets.  <b>FY 2014 Plans:</b> Investigate sensitivity of identified individual difference measures to variability in performance across individuals, tasks, and cognitive states; and evaluate predictive capability of structural networks and/or functional processing for individualized performance assessment.		1.261	1.273
<b>Title:</b> Human System Integration – Cybernetics  <b>Description:</b> Apply a cybernetic approach (theoretical study and comparison of communication and control processes in biological and artificial systems) to human systems integration to achieve tighter control of devices and communication among humans and between machines and humans. Use social, computational, and information approaches to extend the scope of interaction beyond individual systems to the full network context.  <b>FY 2015 Plans:</b> Will determine areas of convergence for cognitive, social, information and computational sciences to develop and apply the cybernetic approach to human centered design of complex systems; invoke neural, information, and social-cybernetic modeling approaches to identify and begin to address the human system integration gaps at the millisecond level and at the team level; examine issues in the design and implementation of cybernetic systems that will enable leveraging of the human nervous system's abilities to integrate, interpret, and utilize multimodal information in the sensory-perceptual-motor decision-making cycle; conduct		-	5.000

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1		<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> 74A / Human Engineering
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b> research using novel paradigms, such as wearable computing and augmented reality technologies to identify key temporal and context parameters in multi-sensory integration; and lay foundation for scaling up to societal-level cybernetics.		<b>FY 2013</b>	<b>FY 2014</b>
<b>Accomplishments/Planned Programs Subtotals</b>		7.576	14.614
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b> N/A			
<b>E. Performance Metrics</b> N/A			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) 74F / Pers Perf & Training			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
74F: Pers Perf & Training	-	6.309	5.716	5.321	-	5.321	5.498	5.580	5.675	5.778	-	-

# The FY 2015 OCO Request will be submitted at a later date.

**Note**

Not applicable for this item.

**A. Mission Description and Budget Item Justification**

This program element provides the funding to develop innovative theories, models, and methods to improve personnel assessment, training, and leader development, as well as provide a better understanding of individual, unit, and organizational behavior and performance within the context of complex organizational and operational environments. The research within these domains will enable advances in psychometrics to support the development of the next generation of psychological assessments for selection, classification, and assignment. The research also will target how to improve the assessment of difficult-to-measure skills and enable theoretical advances to inform and support the accelerated development of complex cognitive and social skills. This research lays the foundation for future applications that address the behavioral and organizational dynamics that impact Army flexibility, effectiveness, and resilience.

Work in this project complements and is fully coordinated with PE 0602785A (Project 790) and PE 0603007A (Project 792).

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

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

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

	<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>
<b>Title:</b> Personnel Measures (previously Human Behavior)	4.471	3.906	1.800
<b>Description:</b> Funding is provided for basic research to develop innovative theories, models, and methods to improve personnel assessment, training, and leader development. In FY15, funds within this Project are realigned to better reflect current efforts.			
<b>FY 2013 Accomplishments:</b> Developed data-driven models to assess the impact of training methods on task performance; identified approaches to enhance experiential learning for guided self-development; and investigated tacit acquisition of cultural knowledge.			
<b>FY 2014 Plans:</b>			

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> 74F / Pers Perf & Training	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
Investigating factors that influence on-the-job learning; identifying predictors of leader development and retention; and identifying contextual facets that influence decision making.			
<b>FY 2015 Plans:</b> Will initiate the development of measurement theory and performance-based measurement methods to improve selection, classification, and assignment.			
<b>Title:</b> Climate, Readiness, and Resilience (previously Human in Complex Organizations) <b>Description:</b> Funding is provided for basic research that will provide a better understanding of individual, unit, and organizational behavior and performance within the context of complex organizational and operational environments. In FY15, funds within this Project are realigned to better reflect current efforts.		1.838	1.810
<b>FY 2013 Accomplishments:</b> Investigated organizational leadership as transmitted through social network links; developed models of unit cohesion within multi-level organizational units.			
<b>FY 2014 Plans:</b> Conducting research to understand social and organizational network variables that affect contextual control; developing real-time assessment and feedback mechanisms to shape group relationships.			
<b>FY 2015 Plans:</b> Will initiate research to develop group and organizational measures of organizational cohesion, resilience, and effectiveness.			
<b>Accomplishments/Planned Programs Subtotals</b>		6.309	5.716
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			



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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) F20 / Adv Propulsion Rsch			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
F20: Adv Propulsion Rsch	-	3.886	4.253	4.108	-	4.108	4.184	4.239	4.309	4.391	-	-

# The FY 2015 OCO Request will be submitted at a later date.

## Note

Not applicable for this item

## A. Mission Description and Budget Item Justification

This project fosters research to increase the performance of small air-breathing engines and power-trains to support improved system mobility, reliability, and survivability for air and/or ground vehicles; and ultimately serve to reduce the logistics cost burden for the future force. Problems addressed include the need for greater fuel efficiency and reduced weight in these propulsion systems. Technical barriers to advanced propulsion systems are the inadequacy of today's materials to safely withstand higher temperature demands, the lack of capability to accurately simulate the flow physics and the mechanical behavior of these systems, including the engine and drive train. The Army is the lead Service in these technology areas and performs basic research in propulsion, as applicable to rotorcraft as well as tracked and wheeled vehicles. Technical solutions are being pursued through analysis, code generation, and evaluations to improve engine and drive train components and investigate advanced materials. Component level investigations include compressors, combustors, turbines, energy sources and conversion, injectors, pistons, cylinder liners, piston rings, gears, seals, bearings, shafts, and controls.

Work in this project provides the technical underpinnings for Program Element (PE) 0602211A (Aviation Technology).

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

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

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

	FY 2013	FY 2014	FY 2015
<b>Title:</b> Thermal Materials	2.303	2.519	2.400
<b>Description:</b> Investigate new materials needed to withstand the higher temperature regimen of advanced high performance engines, and evaluate improved tools and methods that will accurately simulate the flow physics and the mechanical behavior of future engines and drive trains, which will contribute to the design of more fuel efficient and reliable propulsion systems.			
<b>FY 2013 Accomplishments:</b>			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014		
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES	Project (Number/Name) F20 / Adv Propulsion Rsch		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
Determined loading and durability properties associated with hybrid ceramic bearings and hybrid composite gears for next generation Army wheeled tactical and combat vehicle power train concepts.  <b>FY 2014 Plans:</b> Investigate surface engineering techniques to reduce engine and transmission friction losses for improved vehicle fuel economy, reduced maintenance cost, and reduced logistic burden; and establish the capabilities to assess high temperature materials and components for next-generation Army wheeled tactical and combat vehicle power train concepts.  <b>FY 2015 Plans:</b> Will conduct thermo-mechanical fatigue experiments on new bulk ceramic materials, polymer composites, and metal alloys to enable reduced production/maintenance costs, and to achieve increased performance factors with improved temperature capability; and develop advanced computational damage models and conduct mechanical diagnostics experiments to improve the understanding of failure progression and diagnostics in drive train mechanical components, such as gears and bearings.				
<b>Title:</b> Reliable Small Engines for Unmanned Systems  <b>Description:</b> Develop improved tools and methods to enhance the reliability and fuel efficiency of small engines for air and ground vehicles and to enable the use of heavy fuels.  <b>FY 2013 Accomplishments:</b> Established the capability to experimentally evaluate advanced heavy fuel injection spray characteristics under simulated engine conditions in order to optimize combustion performance in future engine concepts.  <b>FY 2014 Plans:</b> Experimentally evaluate advanced heavy fuel injection spray characteristics under simulated engine conditions to optimize combustion performance; use modeling and simulation coupled with experimentation to assess unmanned vehicle engines fueled with JP-8 and other heavy fuels; and evaluate the performance of Army unmanned vehicle engines and small heavy fuel injectors to enable heavy fuel operability and to optimize performance and efficiency.  <b>FY 2015 Plans:</b> Will evaluate transient spray and combustion characteristics of heavy fuel injectors under simulated engine conditions to optimize engine combustion, performance, and efficiency; and develop more accurate and reliable modeling and simulation tools to predict spray and combustion characteristics under complex fluid dynamics conditions that will enable effective design of small engines for a range of Army applications.		1.583	1.734	1.708
Accomplishments/Planned Programs Subtotals		3.886	4.253	4.108

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> F20 / Adv Propulsion Rsch
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A <b>Remarks</b>  <b>D. Acquisition Strategy</b> N/A  <b>E. Performance Metrics</b> N/A		

**UNCLASSIFIED**

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) F22 / Rsch In Veh Mobility			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
F22: Rsch In Veh Mobility	-	0.553	0.612	0.701	-	0.701	0.713	0.723	0.736	0.749	-	-

# The FY 2015 OCO Request will be submitted at a later date.

**A. Mission Description and Budget Item Justification**

This project conducts research in support of advanced military vehicle technology with emphasis on advanced propulsion, sophisticated vehicle dynamics and simulation, vehicle-terrain interaction, vehicle control, and advanced track and suspension concepts. Advanced propulsion research will dramatically improve power density, performance and thermal efficiency for advanced engines, transient heat transfer, high temperature materials and thermodynamics. This project also supports state-of-the-art simulation technologies to achieve a more fundamental understanding of advanced mobility concepts. The subject research is directed at unique, state-of-the-art phenomena in specific areas such as: non-linear ground vehicle control algorithms, using off-road terrain characteristics; and unique mobility approaches, using advanced analytical and experimental procedures.

Work in this project provides the theoretical underpinnings for PE 0602601A (Combat Vehicle and Automotive Technology).  
Work in this project is performed by the Tank and Automotive Research, Development and Engineering Center (TARDEC).

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

	<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>
<b>Title:</b> Advanced Mathematical Algorithms for Improved Vehicle Efficiency	0.553	0.612	0.701
<b>Description:</b> Funding is provided for the following effort:			
<b>FY 2013 Accomplishments:</b> Researched ignition under high pressure injection conditions, and analyzed heat release data for synthetic JP-8 fuel; researched importance sampling techniques for accelerated testing for reliability quantification under stochastic input conditions; explored quantification of model uncertainty with enhanced identification ability; and researched mobility models for small robot terra-mechanics, i.e. the interaction of wheeled or tracked vehicles on various surfaces.			
<b>FY 2014 Plans:</b> Research ignition under high-pressure injection conditions, and analyze heat release data for new fuels; research new analytical tools for characterizing vehicle duty cycles and physics-based vehicle and powertrain dynamics; explore power available for mobility; and research mobility for small platforms (i.e. the interaction of wheeled or tracked vehicles on various surfaces).			
<b>FY 2015 Plans:</b> Will research new physics based analytical tools for more accurately and rapidly predicting vehicle terrain interaction effects; will explore new methodologies/relationships for improving intelligent mobility including latency.			
<b>Accomplishments/Planned Programs Subtotals</b>	0.553	0.612	0.701

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES	Project (Number/Name) F22 / Rsch In Veh Mobility
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A		
<b>Remarks</b>		
<b>D. Acquisition Strategy</b> N/A		
<b>E. Performance Metrics</b> N/A		

# UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) H42 / Materials & Mechanics			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H42: Materials & Mechanics	-	7.865	8.902	9.308	-	9.308	8.662	8.784	8.933	9.098	-	-

# The FY 2015 OCO Request will be submitted at a later date.

## A. Mission Description and Budget Item Justification

This project conducts basic research in materials science, which includes research into key phenomena enabling the creation and production of revolutionary materials that will provide higher performance, lighter weight, lower cost, improved reliability, and environmental compatibility for Army unique applications. The current methodology of using materials to gain added functionality for Army systems is to use a layered approach, whereby each layer provides added capability (e.g., ballistic, chemical/biological, signature, etc.), but ultimately makes the system too heavy and too expensive. Technical solutions are being pursued through understanding the fundamental aspects of chemistry and microstructure that influence the performance and failure mechanisms of ceramics, advanced polymer composites, and advanced metals, with the goal of creating hierarchically organized materials systems that possess multifunctional attributes at greatly reduced weight and cost. These advanced materials will enable revolutionary lethality and survivability technologies for the future.

Work in this project supports key Army needs and provides the technical underpinnings for several Program Elements (PE) to include PE 0602105A (Materials Technology)/ Project H84 (Materials) and PE 0602786A (Warfighter Technology)/H98 (Clothing & Equipment Technology).

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

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

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

	<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>
<b>Title:</b> Microscopic/Nanostructural Materials	2.210	2.615	2.608
<b>Description:</b> Devise new materials and design capabilities based upon fundamental concepts derived at the microscopic and nanostructural levels for the future force.			
<b>FY 2013 Accomplishments:</b> Researched novel composite materials that demonstrate self-healing capability using bio-engineered concepts emerging basic research; and advanced the principles of inverse materials design and applied to emerging material models for future armor designs.			
<b>FY 2014 Plans:</b> Develop mathematical descriptions of full non-linear and transient coupling in armor grade piezoelectric ceramics for novel protection; report on the full-field penetration response of ultra high molecular weight polyethylene (UHMWPE) fabric and fabric			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014		
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES	Project (Number/Name) H42 / Materials & Mechanics		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
systems for application to soldier protection; establish patterned thin film techniques to fabricate a metamaterial lens for corrosion detection under dielectric and paint coatings with high sensitivity; improved adhesion bioinspired polymer adhesives for composite armors. <b>FY 2015 Plans:</b> Will create numerical models and experimental techniques to design energy-absorbing, adaptive, damage-tolerant nanocomposites; develop new paradigms for thermodynamically stable nanostructured materials systems that overcome traditional property trade-offs; and pursue revolutionary new polymeric building block materials for structural, membrane, sensor, and power/energy applications.				
<b>Title:</b> High Deformation Rate Materials <b>Description:</b> Develop fundamental understanding necessary to design, process and characterize materials specifically intended for high loading rate applications, as in armor and armaments. <b>FY 2013 Accomplishments:</b> Developed models to describe specific strengthening mechanisms for novel aluminum alloys and used to cast coupon-scale ingots for experimental validation; and developed synthesis, processing and characterization methods specifically designed for materials in extreme dynamic environments. <b>FY 2014 Plans:</b> Investigate modeling and simulation of clean and doped grain boundaries in boron-based armor ceramics; design novel, thermodynamically stable nanocrystalline alloys for shaped charge liners; determine the importance of composition and microstructure on rate dependent properties of epoxy resins; and complete an initial three dimensional (3-D) microstructural model of lightweight magnesium or aluminum alloys. <b>FY 2015 Plans:</b> Will develop multiscale, multidisciplinary models and related experimental techniques to elucidate fundamental physics of materials response to include: thermoelastic, yield, failure, and fracture behavior at high deformation rates; create novel experimental research tools to enable the study of these high deformation rate phenomena with greater resolution; incorporate microstructural and high deformation response into robust multiscale computational codes; and begin to create new materials specifically designed to enhance performance at high deformation rates in applications ranging from armor to new armaments.		2.802	3.113	3.400
<b>Title:</b> Materials Research and Processing at Small Scale <b>Description:</b> Elucidate and exploit unique structure, processing, and property relationships that occur in materials at small length scales and develop methods to tailor the physical, chemical and mechanical response of these materials to enable unprecedented performance improvements in materials properties.		2.853	3.174	3.300

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> H42 / Materials & Mechanics	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p><b>FY 2013 Accomplishments:</b> Developed novel polymeric materials which are thermally and chemically stable under extreme operating conditions; investigated and developed modeling and simulation methods specifically designed for materials used in extreme dynamic environments.</p> <p><b>FY 2014 Plans:</b> Validate new multi-axial mechanical characterization methods and apply to conventional and novel ballistic fibers to elucidate the effect of nanostructure; develop in-situ capabilities for electron microscopy to elucidate the mechanical response of soft tissue and polymer gels; characterize the water transport properties of polymer electrolyte materials.</p> <p><b>FY 2015 Plans:</b> Will develop an integrated computational materials science capability that clarifies relevant physical mechanisms and enables the rational design of small scale (nanoscale) and bio-inspired building blocks; utilize thermodynamic and kinetic studies of self-assembly processes to design, create, and characterize nanostructured surfaces and interfaces; and create and utilize small scale materials characterization techniques to further the fundamental understanding of small scale materials and processes.</p>			
<b>Accomplishments/Planned Programs Subtotals</b>		7.865	8.902
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			



## UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) H43 / Research In Ballistics			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H43: Research In Ballistics	-	8.299	9.378	8.810	-	8.810	8.462	8.579	8.722	8.886	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
Note Not applicable for this item												
A. Mission Description and Budget Item Justification												
This project seeks to improve the understanding of the chemistry and physics controlling the propulsion, launch, and flight of gun-launched projectiles and missiles, and to understand the interaction of these weapons with armored targets. This research results in basic new knowledge, which allows the formulation of more energetic propellants, more accurate and non-lethal (NL)/lethal projectiles and missiles, and advanced armors for increased survivability of Army combat systems. This effort supports the Office of the Secretary of Defense Advanced Energetics Initiative to mature the fundamental technologies required to transition the next generation of energetic materials into field use.												
Work in this project supports key Army needs and provides the theoretical unerpinnings to several Program Elements (PEs) to include PE 0602618A (Ballistics Technology)/Project H80 (Survivability and Lethality Technology).												
The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology focus areas and the Army Modernization Strategy.												
Work in this project is performed by the U.S. Army Research Laboratory (ARL), Aberdeen Proving Ground, Adelphi, MD, and Research Triangle Park, NC.												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2013	FY 2014	FY 2015	
Title: Advanced Energetics Initiative									2.689	3.011	3.600	
Description: Expand and confirm physics based models and validation techniques to enable design of novel insensitive propellants/explosives with tailored energy release for revolutionary future force survivability and weapons effectiveness.												
FY 2013 Accomplishments: Extended quantum mechanical based models to enable prediction of key performance and vulnerability properties; determined feasibility of nontraditional energetic materials containing stored structural energy (e.g., extended solids), and identified factors influencing stabilization for designing future disruptive energetic materials.												
FY 2014 Plans:												

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014		
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES	Project (Number/Name) H43 / Research In Ballistics		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
Synthesize and fabricate gram quantities of disruptive energetic materials that have two-fold energy content compared to conventional explosives; develop reactive variants of the dissipative particle dynamics method with multi-step chemical reactions and perform simulations of multi-scale coarse grain models to determine pressure dependent stress-strain behavior for input into plasticity model; and refine and validate existing model via comparison with nano-indentation experiments.  <b>FY 2015 Plans:</b> Will exploit material micro/nanostructure, high pressure synthesis, and managed energy release mechanisms to develop energetic materials with 2-10 times the energy content of conventional explosives; further advance theory required to develop accurate descriptions and models of condensed phase processes, quantum mechanical reactive potential energy surfaces, shock impact, initiation and detonation phenomena, and ignition and combustion; and further develop synthetic capabilities to produce high-nitrogen containing materials.				
<b>Title:</b> Launch and Flight of Gun Launched Projectiles as well as Missiles  <b>Description:</b> Improve the fundamental understanding of the mechanisms controlling the launch and flight of gun launched projectiles and missiles, and understand the interaction of these weapons with armored targets.  <b>FY 2013 Accomplishments:</b> Developed and validated coupled computational fluid dynamics, flight dynamics, and rigid body dynamics techniques in a single computational model to predict non-linear aerodynamic behavior of maneuvering precision munitions; characterized theoretically and experimentally coupled global positioning system (GPS) and navigation concepts for the next generation of highly dynamic, spinning projectiles; and investigated the fundamental mechanical interaction of human brain tissue with shock waves that occur during ballistic events.  <b>FY 2014 Plans:</b> Continue to develop first principles state-of-the-art computational aerodynamics techniques using coupled computational fluid dynamics (CFD), rigid body dynamics (RBD) and flight control systems (FCS) to exploit novel flow physics and increase maneuverability for next generation, low cost, hyper-accurate munitions; add structural dynamics model to simulate guided maneuvers and unsteady effects; and compute a coupled calculation of a canard-controlled finned projectile (using a skid-to-turn maneuver), compute and validate a roll maneuver (with dynamic wind tunnel data), and simulate uncontrolled and controlled trajectories (of a long flexible finned body).  <b>FY 2015 Plans:</b> Will further development of computational aerodynamics capabilities, coupled with the development of next-generation guidance, navigation, and control solutions to enable new paradigms in maneuverability to achieve ultrahigh precision.		1.599	1.768	1.710
<b>Title:</b> Extramural Research in Non-Lethal (NL) Control Methods		1.061	1.275	-

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> H43 / Research In Ballistics	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p><b>Description:</b> Extramural research in NL control methods to exploit potentially innovative approaches that offer unique battlefield and homeland defense capabilities.</p> <p><b>FY 2013 Accomplishments:</b> Studied the decomposition pathways of energetic materials to elucidate the molecular decomposition behavior at the individual molecule scale; created new approaches and methods to reduce effects of complex noise and missing data for exploiting sparse hyperspectral and multimodal data; and established novel approaches for scalable indexing and retrieval of large image datasets that are necessary for effective analysis and exploitation of knowledge databases.</p> <p><b>FY 2014 Plans:</b> Develop statistical methods to analyze spatially and temporally evolving patterns designed to provide decision makers with the capability to distill concise meaning from large quantities of experimental observations.</p>			
<p><b>Title:</b> Armor Research</p> <p><b>Description:</b> Develop fundamental knowledge of mechanisms that can be exploited to ensure the next generation of lightweight and efficient armor technologies.</p> <p><b>FY 2013 Accomplishments:</b> Developed the capability to measure electromechanical stress in very small samples deforming at very high strain rates and explored the effects of high magnetic field on the stress response within these deforming solids; and developed fundamental underpinnings of the electrical conductivity within the shock cone that forms around hypervelocity penetrators.</p> <p><b>FY 2014 Plans:</b> Develop a model for thermo-physical properties of plasmas and explore advanced electro-magnetic effects using hydrocodes and experimentation to better understand conductivity and fields in order to optimize electromagnetic armors; advance computational models by exploring dynamic effects in three dimensions (3-D); and study the physics of using electromagnetic fields to enhance the detonation of energetic materials to include designing a new diagnostic tool to study the detonation zone.</p> <p><b>FY 2015 Plans:</b> Will establish capabilities to extract electron temperature data from time resolved imaging spectroscopy measurements of shaped charge jet induced plasma for comparison to numerical simulation predictions; develop hierarchical multiscale methodology for transfer of relevant information from mesoscale computation to macroscale constitutive and failure models; and develop coupled finite element and physiological numerical modeling methods to evaluate the dynamic response of the human head as a structure under short-time blast loading to enable effective design of protection concepts.</p>		2.950	3.324
<b>Accomplishments/Planned Programs Subtotals</b>		8.299	9.378
			8.810

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES	Project (Number/Name) H43 / Research In Ballistics
<u>C. Other Program Funding Summary (\$ in Millions)</u> N/A		
<u>Remarks</u>		
<u>D. Acquisition Strategy</u> N/A		
<u>E. Performance Metrics</u> N/A		

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) H44 / Adv Sensors Research			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H44: Adv Sensors Research	-	9.403	10.342	9.810	-	9.810	7.714	7.664	7.742	8.000	-	-

# The FY 2015 OCO Request will be submitted at a later date.

## Note

Not applicable for this item

## A. Mission Description and Budget Item Justification

This project supports basic research to produce future generations of sensors with capabilities beyond those currently being employed. Technical barriers include the fundamental speed and bandwidth limitations of current materials and devices, the efficiency of current algorithms, current computing architectures, organic material lifetimes, the understanding of the fundamental concepts of quantum cryptography, and spatial resolution of current radio frequency (RF) sensors. The technical approach is to exploit large scale electromagnetic (EM) models to predict and explain target and clutter scattering behavior, digital and image processing modules and algorithms, beam propagation and material modeling of nonlinear optical effects, hazardous material detection, remote sensing and intelligent system distributive interactive simulations, unique sensor development, sensor data feature and information fusion in the concept of Data-to-Decisions (D2D), and battlefield acoustic signal processing algorithms. Research performed under this project also supports survivable sensor systems, organic thin film transistor technology and organic light emitting diode technology for affordable rugged flexible displays. This project also funds research in the development of biologically inspired materials for use as sensors as well as for power generation and storage; and physics-based multi-scale models for electronic, optical, mechanical, and chemical materials. Payoffs include high-data-rate military communications, low cost compact flexible displays for the Soldier and for the Army, improved radar signal processing techniques that will allow existing systems to improve spatial resolution, improved ultra wideband radar technology for detection of explosives including mine detection, through the wall sensing and robotics perception, improved sensor approaches and signal processing techniques for enhanced acoustic/seismic sensing systems in noisy environments, distributed sensor data fusion in ad hoc networks, improved cryptography techniques, improved understanding of the physics and atomic properties of materials, and capabilities in hazardous material and event sensing.

Work in this project supports key Army needs and provides the theoretical underpinnings to several Program Elements (PEs) to include PE 0602786A (Warfighter Technology)/Project H98 (Clothing & Equipment Technology).

Work in this project complements and is fully coordinated with research at the U.S. Army Armaments Research, Development, and Engineering Center (ARDEC); the U.S. Army Communications Electronics Research, Development, and Engineering Center (CERDEC), the U.S. Army Natick Soldier RDEC (NSRDEC) and the U.S. Army Edgewood Chemical Biological Center (ECBC).

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.

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014	
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES	Project (Number/Name) H44 / Adv Sensors Research	
Work in this project is performed by the U.S. Army Research Laboratory (ARL), Adelphi, MD.			
B. Accomplishments/Planned Programs (\$ in Millions)	FY 2013	FY 2014	FY 2015
<p><b>Title:</b> Adaptive, Active, and Intelligent Optical Systems</p> <p><b>Description:</b> Adaptive, active, and intelligent optical systems for high-data-rate military communications and directed energy applications.</p> <p><b>FY 2013 Accomplishments:</b> Investigated and developed advanced Army battle-space tactical and long-range atmospheric laser communication and imaging technologies to achieve high bandwidth communication, high fidelity visualization, and allow utilization of advanced command and control techniques; developed novel processing techniques to extend the use of quantum imaging to tactical environments in order to improve battlefield communications.</p> <p><b>FY 2014 Plans:</b> Develop application of advanced Army battle-space tactical, short-haul, and long-range atmospheric laser ultraviolet/light-emitting diode/radio frequency (UV/LED/RF) communication and imaging technologies to achieve high bandwidth communication, high fidelity visualization, and allow utilization of advanced command and control techniques (including improving comprehensive link modeling and prediction of ultraviolet communication (UVC) and visible light communication (VLC), including atmospheric propagation, source and detection technology, and modulation and coding strategies); and investigate and develop novel quantum physics and coupled processing techniques to provide tactically superior quantum imaging and battlefield communications particularly in obscured, obstructed, or adverse tactical environments.</p> <p><b>FY 2015 Plans:</b> Will complete the optimization of the pointing, acquisition, and tracking sub-systems of the Free-Space Optical (FSO) networked multi-gigabit communication system; conduct a performance evaluation of the FSO and its related control software; and develop ARL visible light multispectral quantum imager capable of imaging through turbulence and demonstrate its capability in turbulence and low light field experiments to beyond 1 km.</p>	1.687	1.860	1.810
<p><b>Title:</b> Improving Sensor and Photonics Research (Nano)</p> <p><b>Description:</b> Create more survivable and secure sensors and displays; improve hazardous material monitoring; and investigate new magnetic sensor technologies for personnel and improvised explosive device (IED) detection.</p> <p><b>FY 2013 Accomplishments:</b> Developed sensor fusion algorithms to enable the aggregation of data features into information within the context of data-to-decision (D2D); developed theoretical understanding of metaferrites (using analytical and computer simulations) as an enabling technology for low-profile and embedded antenna enhancements; analyzed and developed algorithms to exploit co-registered video and radar imagery to enhance detection of landmines and IEDs with reduced false alarms; enhanced acoustic sensor</p>	2.554	2.817	3.000

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> H44 / Adv Sensors Research	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
and array performance through wind mitigation and adaptive algorithms for improved event classification; evaluated conductive organic materials and high stability organic light emitting diode (OLEDs) for transition into OLED displays and emerging sensor applications; and developed noise resistant magnetic sensors to improve signal-to-noise ratio (SNR) and detection range for counter IED technologies.			
<b>FY 2014 Plans:</b> Develop time-domain acoustic models that incorporate ground impedance and atmospheric effects to create synthetic sensor waveform data in various environments for training and evaluating acoustic classification algorithms. Investigate utilization of spin-torque-oscillators for reading non-erasable magnetic memory; develop algorithms and software for modeling non-linear signature response of RF devices in complex urban environments; perform theoretical and experimental analysis on metamaterials with randomly oriented unit cells and investigate the viability of their use in RF lens structures (e.g., a Rotman lens); and research organic devices and materials and diodes for large-area radiation and particle sensors utilizing charge-transfer electro-chemical designs.			
<b>FY 2015 Plans:</b> Will research methods to improve acoustic classification robustness in diverse environments; study a physics-based tracker algorithm for extremely long-range infrasound (low-frequency sound) detections; research methods to improve sensitivity and miniaturize interface of magnetic tunnel junction sensor sensitivity and interface for reading non-erasable magnetic memory permeability bits of stored information; and investigate signal processing algorithms for exploiting flexible and adaptable low frequency ultra-wideband (UWB) waveforms that support stepped frequency radar technology.			
<b>Title:</b> Engineered Biotechnology		2.822	3.108
<b>Description:</b> Use a multi-scale modeling approach to investigate biological systems to develop biologically-inspired sensors as well as bio-inspired power generation and storage techniques.			-
<b>FY 2013 Accomplishments:</b> Evaluated biofilm contaminate-sensing genetic constructs against actual logistics fluid specimens for both JP-8 and potable water; manipulated bio-assembled electronic structures by controlled deposition of infrared (IR) sensitive materials and characterized the resulting complexes; transitioned to larger two dimensional (2-D) assemblies appropriate for traditional electronic manufacturing; analyzed engineered strains against models for generation of organic fuels to evaluate information collected from systems biology approaches; investigated the improvement of advanced modeling techniques through the use of an iterative approach of multi-scale modeling and increased biological characterization; and examined genotype to phenotype relationship of laboratory bacterial cultures to determine a means for identification.			
<b>FY 2014 Plans:</b>			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014		
Appropriation/Budget Activity 2040 / 1		R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES		Project (Number/Name) H44 / Adv Sensors Research	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>			<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>
Use synthetic biology, building off of previous genetic sensing constructs, to engineer sense and respond module for neutralizing biological contamination; develop second generation peptide recognition elements using an iterative process involving computational modeling coupled with experimental characterization for materials that perform in extreme environments; use synthetic microbiology to engineer second generation strains for production commodity chemicals based upon predictions made in FY13; and use biological characterization data generated in FY13 to refine advanced modeling techniques of multi-scale modeling for prediction of improved biological interactions.					
<b>Title:</b> Multi-Scale Modeling for Novel Materials  <b>Description:</b> Explore and develop multiscale modeling techniques to support fundamental studies of electronic and structural materials properties from the atomistic to the continuum. Resulting models are needed to design/ develop materials for more efficient, longer lifetime sensors and power and energy devices, and lighter materials for vehicle and soldier protection. This efforts includes crosscutting research that leverages two 5-year Collaborative Research Alliances.  <b>FY 2013 Accomplishments:</b> Conducted fundamental studies of materials to identify and model physics and atomic interactions that define their electronic and optical properties and characteristics; evolved interface physics between nano- and meso-scales up to the continuum; expanded upon and created new multi-scale experimental techniques and characterization methods to probe materials nano- and microstructure, including defects at interfaces and response under extreme conditions; evolved web-based security schemes for external and internal project users to foster multi-disciplinary collaboration; and examined multi-scale computational science environment to facilitate coupling of different software programs/algorithms; advanced methods to support high performance computing users and software developers.  <b>FY 2014 Plans:</b> Use FY13 results to design and expand fundamental studies to identify and model physics and atomic interactions that define their structural, mechanical, electronic, and optical properties and characteristics and control material deformation, progressive/ catastrophic failure, and phase response across length scales; establish fundamental underpinnings of physics between nano- and meso-scales up to the continuum; continue to develop new multi-scale experimental techniques and characterization methods to probe materials microstructure, including defects and interfaces, and responses under extreme conditions; develop advanced computational models for multiscale modeling of electrochemical systems; investigate and develop scalable interdisciplinary data models to address spatial one-way coupling of software on massively parallel petaflop systems, and multi-core computing systems; create and disseminate web-based security schemes for external and internal project users to foster multi-disciplinary collaboration; conduct research in multi-scale computational sciences and couple different modeling paradigms at the algorithm level; and advance methods to support high performance computing users and software developers.  <b>FY 2015 Plans:</b>			2.340	2.557	3.000



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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014	
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES	Project (Number/Name) H44 / Adv Sensors Research	
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014
Will continue to perform fundamental studies to identify and model the physics and atomic interactions that define their structural, mechanical, electronic, and optical properties and characteristics and control material deformation, progressive/catastrophic failure, and phase response across length scales; validate multi-scale experimental techniques and characterization methods; continue to develop advanced computational models for multiscale modeling of electrochemical systems; investigate and develop scalable interdisciplinary data models to address spatial one-way coupling of software on massively parallel petaflop systems, and multi-core computing systems; and conduct research in multi-scale computational sciences and couple different modeling paradigms at the algorithm level.			
<b>Title:</b> Bio-inspired Materials and Devices Research <b>Description:</b> Create synthetic biological materials for electronic devices and force protection. <b>FY 2015 Plans:</b> Will investigate the underlying biology that enables natural and synthetic biological materials and systems to monitor, control, enhance, and predict bacterial metabolism and products for improved logistics and force protection; study novel synthetic recognition reagents in response to new and emerging threats that possess superior performance, stability and adaptability; and research hybrid biological/electronic/photonic materials capabilities based on bio-engineered cellular machinery or specific properties of bio-interfacial chemistry.		-	2.000
Accomplishments/Planned Programs Subtotals		9.403	10.342
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 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) H45 / Air Mobility			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H45: Air Mobility	-	2.275	2.550	2.303	-	2.303	2.345	2.377	2.417	2.463	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
Note Not applicable for this item												
A. Mission Description and Budget Item Justification												
This project supports basic research in aerodynamics for manned and unmanned rotary wing aircraft. The goal of this effort is to develop improved tools and methods to analyze, evaluate, and assess rotorcraft-unique aerodynamic properties in conventional helicopter and tilt-rotor aircraft. The efforts in this project will result in a better understanding of rotorcraft aeromechanics and will result in improved performance, safety and, ultimately, improved combat effectiveness of the manned and unmanned rotorcraft in the future force. This project supports the future force by providing research into technologies that can improve tactical mobility, reduce logistics footprint, and increase survivability for rotary wing aircraft.												
Work in this project provides the theoretical underpinnings for PE 0602211A (Aviation Technologies).												
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 Aviation & Missile Research, Development and Engineering Center, Aero-Flight Dynamics Directorate at NASA Ames Research Center, CA and Langley Research Center, VA.												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2013	FY 2014	FY 2015	
Title: Rotary Wing Aerodynamics									2.275	2.550	2.303	
Description: Funding is provided for the following effort												
FY 2013 Accomplishments: Experimentally investigated detailed helicopter wake structure for the existence of worm-like fluid phenomena seen in computational fluid dynamics (CFD) calculations; analytically / numerically investigated the oscillation encountered in CFD prediction for hover performance; and assessed the importance of the fuselage impedance on rotor blade structural loads and helicopter vibration.												
FY 2014 Plans:												

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> H45 / Air Mobility	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
Continue computational aero-science investigations using numerical methods including work on validation and development testing the physical assumptions forming the building blocks of the underlying theory. Continue fundamental experiments aimed at the underlying physics of rotor downwash flow fields and rotorcraft testing techniques such as pressure sensitive paint.			
<b>FY 2015 Plans:</b> Will continue computational aero-science investigations aimed at developing novel numerical methods for rotorcraft unique flow phenomena and will continue fundamental aeromechanics experiments; will conduct an experimental investigation of rotor wake physics including worm-like flow instabilities; will investigate flow phenomena in unsteady flow separation; and will develop and improve testing techniques for aerodynamics / fluid flow such as pressure sensitive paint and particle image velocimetry.			
<b>Accomplishments/Planned Programs Subtotals</b>		2.275	2.550
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b> N/A			
<b>E. Performance Metrics</b> N/A			

# UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014			
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) H47 / Applied Physics Rsch				
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost	
H47: Applied Physics Rsch	-	4.838	5.268	5.306	-	5.306	5.200	5.271	5.360	5.460	-	-	
# The FY 2015 OCO Request will be submitted at a later date.													
Note Not applicable for this item													
A. Mission Description and Budget Item Justification													
This project performs basic research on electronic materials and structures as well as technologies in energy harvesting and energetic materials, batteries and fuel cells to enable higher performance and more efficient electronic systems. This includes nanoelectronic devices for low-power and high-frequency applications; sensors, emissive nonlinear and nanophase electrodes, and electronic materials; advanced battery materials, thermoelectric devices, photovoltaic devices as well as more efficient fuel cells for hybrid power; and the manipulation of cold atoms on a chip for application to very sensitive sensors and ultra-stable atomic clocks. These investigations will impact the development of power sources and specialty electronic materials for the Army's future force, including improved wide band gap semiconductor performance for more electric platforms, nanomaterials for batteries and fuel cells, quantum dots for increased photovoltaic efficiency and advanced radar systems. Applications of cold atom chips include gyroscopes and accelerometers for inertial navigation units in global positioning system (GPS) denied environments, gravitational sensors for detecting underground facilities, very-low-phase noise precision oscillators for low-velocity Doppler radar, and atomic clocks for GPS denied environments as well as for future space-based timing applications. Technical barriers affecting performance, weight, cost, and power consumption will be addressed.													
Work in this project supports key Army needs and provides the technical underpinnings to several Program Elements (PEs) to include PE 0602705A (Electronics and Electronic Devices)/Project H94 (Electronics & Electronic Devices). Work in this project complements and is fully coordinated with research at the U.S. Army Armaments Research, Development, and Engineering Center (ARDEC); the U.S. Army Communications Electronics Research, Development, and Engineering Center (CERDEC); and the U.S. Army Natick Soldier Research, Development, and Engineering Center (NSRDEC).													
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.													
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2013	FY 2014	FY 2015		
Title: Nanoelectronic Devices and Sensors									2.954	3.235	3.006		
Description: Conducts research for advanced battery materials; fuel cells and reformers for Soldier and vehicle power; electronic materials structures and defects of high-temperature wide-band gap semiconductors for high-power electronic applications;													

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> H47 / Applied Physics Rsch	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p>materials for advanced nano and micro devices; cold-atom chip devices for advanced sensors and ultra-stable atomic clocks; and integration of nanoenergetics and Micro-Electro-Mechanical Systems (MEMS) for fusing and microrobotic applications.</p> <p><b>FY 2013 Accomplishments:</b> Experimentally validated multiscale models for electrochemical transport and charge transfer in electrochemical devices to optimize performance; investigated novel nanostructures for battery and fuel cell electrodes for increased efficiency; examined large area growth, material transfer, and substrate interactions of carbon based nanoelectronics for increased capabilities and reduced power consumption of battlefield electronics; investigated three dimensional (3-D) growth and patterning of piezoelectric materials for low power large displacement MEMS actuators; investigated methods and formulations for detonation using on-chip energetic materials; investigated emerging nanostructured materials (carbon nanotube, graphene, silicon carbide, diamond) for energy storage electrodes, thin films, and energy conversion applications; characterized interference fringes using cold atoms on an atom chip; and investigated gallium nitride/aluminium gallium nitride (GaN/AlGaN) and other wide-bandgap materials and device structure characteristics under high power conditions for improved electrical efficiency and associated thermal management.</p> <p><b>FY 2014 Plans:</b> Study decoherence mechanisms and optical Raman techniques to coherently control cold atoms and atomic spin to improve the sensitivity of a chip-scale atom interferometer for inertial navigation in GPS denied environments; investigate and evaluate actuator designs using piezoelectric actuators using 3-dimensional growth and patterning techniques; investigate modes of propagation for on-chip energetic materials and determining factors that influence reaction rate; develop novel two-dimensional (2-D) material growth, characterization, transfer and processing technology and conduct experiments to achieve electronic device quality materials for nanoelectronics and supercapacitors; investigate solid electrolyte interphase (SEI) formation on silicon (Si) anodes for lithium (Li) ion batteries; investigate GaN for high power conditions by improving breakdown voltage and crystalline via reduced contaminants with improved electrical efficiency and associated thermal management; and investigate materials structures for catalyst activities for energy conversion.</p> <p><b>FY 2015 Plans:</b> Will investigate transport of cold atoms along chip-scale wires for applications in inertial navigation in GPS denied environments and for applications in environmental sensing, including magnetometry; investigate integration of 3-D piezoelectric materials and processes with flexible substrate and circuit technologies for radio frequency (RF) MEMS and millimeter scale robotics; study and characterize the growth and electrical properties of stacked 2-D electronic materials for application to RF and/or logic devices; and refine the early development of on-chip energetic materials and processing for supplying slow, high temperature thermal sources.</p>			
<b>Title:</b> Advanced Energy Science Research		1.884	2.033
			2.300

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014	
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES	Project (Number/Name) H47 / Applied Physics Rsch	
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014
<p><b>Description:</b> Conduct materials research and multi-scale modeling that will lead to advances in energy storage, harvesting, and conversion for a wide range of Army applications such as Soldiers, platforms, and microgrids.</p> <p><b>FY 2013 Accomplishments:</b> Conducted research on the design, fabrication and characterization of material properties in coordination with modeling and theoretical computations for energy storage and conversion materials; investigated methods for developing multi-scale computational and simulation tools supporting the development of materials for electrochemical energy conversion and generation; designed and experimented novel energy harvesting (light, heat, vibration, isotope, biological energy, sources) methods; investigated emerging nanostructured materials (carbon nanotube, graphene, silicon carbide, and diamond) for energy storage electrodes, and energy conversion applications; and investigated advanced device architectures for thermoelectric and photovoltaic devices for increased energy conversion efficiency.</p> <p><b>FY 2014 Plans:</b> Investigate wide-band gap semiconductor materials for direct photoelectrochemical production of hydrogen gas for use as fuel; and research novel device architectures for solar energy conversion.</p> <p><b>FY 2015 Plans:</b> Will study the physical limits of wide-band gap materials for direct photoelectrochemical production of hydrogen for use as fuel; investigate the effect of plasmonic arrays on the catalysis of oxygen reduction and ethanol oxidation as alternative methods for fuel production; and develop advanced superconducting materials by metal organic chemical vapor deposition (MOCVD) processes to aid in energy conversion.</p>			
Accomplishments/Planned Programs Subtotals		4.838	5.268
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 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) H48 / Battlespace Info & Comm Rsc			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H48: Battlespace Info & Comm Rsc	-	19.563	21.545	25.320	-	25.320	25.633	25.821	25.662	23.909	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
Note Not applicable to this item												
A. Mission Description and Budget Item Justification This project supports basic research to enable intelligent and survivable command and control, communication, computing, and intelligence (C4I) systems for the future force. As the combat force structure decreases and operates in more dispersed formations, information systems must be more robust, intelligent, interoperable, and survivable if the Army is to retain both information and maneuver dominance. This research supports the Army's Network Science initiative and addresses the areas of information assurance, signal processing for wireless battlefield communications, document and speech machine translation, and intelligent systems for C4I. Major barriers to achieving the goals are the inherent vulnerabilities associated with using standardized protocols and commercial technologies while addressing survivability in a unique hostile military environment that includes highly mobile nodes and infrastructure, bandwidth-constrained communications at lower echelons, resource-constrained sensor networks, diverse networks with dynamic topologies, high-level multi-path interference and fading, jamming and multi-access interference, levels of noise in speech signals and document images, new low-density languages, and information warfare threats. These C4I technologies must accommodate heterogeneous security infrastructures and information exchange/security mechanisms between multiple levels of security. The intelligent systems for C4I research focuses on providing the agent technology capabilities that will produce highly relevant tactical events for mounted or dismounted commanders, leaders and Soldiers; improve the timeliness, quality and effectiveness of actions; and speed the decision-making process of small teams operating in complex natural or urban terrain.  Work in this project supports key Army needs and provides the technical underpinnings to several Program Elements (PEs) to include PE 0602783A(Computer and Software Technology)/Project Y10(Computer/Information Science 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.												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2013	FY 2014	FY 2015	
Title: Communication for Tactical Networks									1.635	1.822	1.900	

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014		
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES	Project (Number/Name) H48 / Battlespace Info & Comm Rsc		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
<p><b>Description:</b> Perform research to provide communications capability for a fully-mobile, fully-communicating, and situationally-aware force operating in a highly dynamic, wireless, mobile networking environment populated by hundreds to thousands of networked nodes.</p> <p><b>FY 2013 Accomplishments:</b> Developed techniques to enhance overall operational capacity and military effectiveness of networks by adaptive management of quality of information and user trust in composite networks. The results contributed to novel capabilities in tactical mobile communication networks that enhance effective communications of Warfighters in the networks by maximizing delivery of information of highest quality as well as managing trust in the information and the network.</p> <p><b>FY 2014 Plans:</b> Develop a framework for modeling quality of information, which enhances communications by delivering more relevant information (enhancing decision making); research use of non-traditional communication technologies (optical &amp; ultra-violet (UV)) to support connectivity in radio frequency (RF) challenged environments; and identify and develop limits, techniques and algorithms for unicast and multicast communications over hybrid networks (wired and wireless networks).</p> <p><b>FY 2015 Plans:</b> Will conduct analysis, simulation, and experiments to develop new communications networking capability in harsh tactical environments (exploitation of low frequency communications, mobility and autonomy to maintain connectivity, and mapping connectivity regions to blend with mobility planning and sensing); develop quality of information theories based upon human-in-the-loop analysis; and develop mathematical representations for the quality of information of static and dynamic data and its effectiveness for situational awareness.</p>				
<p><b>Title:</b> Data to Knowledge to Support Decision Making</p> <p><b>Description:</b> Design and implement a laboratory-scale common information-processing infrastructure, inclusive of cloud computing for networking processes that aids in the transformation of data into actionable intelligence to support decision-making under uncertainty.</p> <p><b>FY 2013 Accomplishments:</b> Investigated techniques for more closely coupling decision algorithms with image processing techniques to enhance and accelerate current data collection and information retrieval algorithms to improve exploitation of tactical intelligence.</p> <p><b>FY 2014 Plans:</b> Investigate algorithms and techniques (in-house, academia, and industry) for exploiting context and value of information from unstructured full motion imagery and text including the leveraging of industry investment in graphic processing units (GPU) and</p>		2.377	2.653	2.500



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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014		
Appropriation/Budget Activity 2040 / 1		R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES		Project (Number/Name) H48 / Battlespace Info & Comm Rsc
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
cluster-based computing architectures; investigate techniques for adaptive data collection on collaborating mobile platforms to improve current decision making capabilities.				
FY 2015 Plans: Will research the effect of context-dependent information exploitation on the situation awareness of intelligence analyst and soldiers at the edge by constraining the problem domain in an effort to reduce computational complexity and increase accuracy of specific baseline algorithms; experimentally validate the value of information construct within a tactical military decision support system; and investigate algorithms for intelligent exploration and focused data collection in relevant environments using collaborative mobile platforms.				
Title: Information Protection for Mobile Ad-Hoc Networks (MANET)s		4.371	4.998	6.100
Description: Perform research in protecting information in highly mobile wireless tactical environments, where networks must operate under severe bandwidth, energy, and processing constraints, and without reliance on centralized security services. Beginning in FY15, includes work previously conducted under Network Science for MANETs nd Tactical Communications.				
FY 2013 Accomplishments: Developed new security protocols suitable for use in hybrid networks by leveraging and integrating techniques of both wireless and wired environments. The new protocols contribute to novel capabilities that enable the Warfighters to detect and defeat malicious activities of adversaries on tactical networks and hosts in MANETs, with a special focus on mobility effects.				
FY 2014 Plans: Enhance security techniques and algorithms decrease detection time and ensure information protection while maintaining suitability for operation in both tactical mobile and hybrid networking environments. These methods will improve the capability of Soldiers to detect and defeat malicious activities of adversaries on mobile tactical networks.				
FY 2015 Plans: Will develop security processes and techniques to provide information protection in mobile dynamic environments, where mobile devices are connected to coalition networks serving as forward-deployed devices at the edge; develop techniques to minimize energy required to support security functions; develop security protocols and processes for using tactical cloudlets as a shared resource among Warfighters and coalition forces; and develop and characterize algorithms for detection and analysis of adversarial malicious operations on networks that involve the above mentioned complexity of mobility, resource constraints, inconsistency and shared resources.				
Title: Multi-Lingual Computing Research		1.050	1.169	1.100
Description: Establishes formal methods for bridging language barriers in tactical environments, incorporating state of the art techniques in machine translation and natural language processing.				

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014		
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES	Project (Number/Name) H48 / Battlespace Info & Comm Rsc		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
<b>FY 2013 Accomplishments:</b> Developed novel techniques for quantifying language similarity across military domains and assess the effectiveness of those techniques in extending existing translation engines to new military decision constraints in order to improve Soldier effectiveness in foreign-language tactical environments.  <b>FY 2014 Plans:</b> Investigate use of information extracted from machine translated text in constructing task-based metrics and predictive models of machine translation quality, for low-resource languages and domains. This will enable situation awareness when information sources are multi-lingual in nature.  <b>FY 2015 Plans:</b> Will identify and extract event-based information from large amounts of text written in different genres in different languages and dialects to support temporal and spatial relation analyses in situational awareness; and examine the extension of linguistics analysis techniques to image processing.				
<b>Title:</b> Network Science for MANETs and Tactical Communications  <b>Description:</b> Study the behavior of mobile ad-hoc networks (MANETs) as part of the Army's Network Science initiative. Emphasis is on mobile communications networks research with the Army's University Affiliated Research Center, the Institute for Collaborative Biotechnologies at the University of California, Santa Barbara (PE 0601104A/Project H05). In FY15 this effort is moved to Information Protection for MANETs.  <b>FY 2013 Accomplishments:</b> Developed techniques and algorithms for assessing and optimizing the impact of social, cognitive and information structures on the behavior and performance of Army networks. The resulting techniques and algorithms support network technologies to enable Warfighters to anticipate and manage information, and social and communication effects, in network-enabled Mission Command.  <b>FY 2014 Plans:</b> Develop methodologies, techniques and algorithms for the analysis of realistic finite networks, that will provide insights for the design and provisioning of tactical, mobile, ad-hoc networks to improve network performance; and develop mathematical models of dynamic networks that will enable the representation of group interactions, the analysis of the behaviors of such networks, and the characterization of the fundamental limits on information flow within such networks.		0.923	1.027	-
<b>Title:</b> Advanced Computing  <b>Description:</b> Investigate computing and networking architectures, algorithms, and visualization techniques to support advanced battle command applications for Command, Control, Communications, Computer, and Intelligence (C4I) systems.		3.358	3.756	3.500

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / <i>DEFENSE RESEARCH SCIENCES</i>	<b>Project (Number/Name)</b> H48 / <i>Battlespace Info &amp; Comm Rsc</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p><b><i>FY 2013 Accomplishments:</i></b> Implemented new scalable programming models for cloud-computing and performed benchmarking for the ARL Mobile Network Modeling Institute battle scenario of C4ISR-on the move. The advanced computing approaches support taking supercomputing as a deployable asset to the battlefield enhancing real-time Situational Awareness in tactical environments.</p> <p><b><i>FY 2014 Plans:</i></b> Explore use of mathematical approaches that allow the prediction of certain outcomes using incomplete information and develop scenarios for verification and validation; and verify and validate scalable programming models and software developed for tactical computing concept.</p> <p><b><i>FY 2015 Plans:</i></b> Will explore novel models to represent advanced computing coupled with real-time battlefield information processing while meeting tactically relevant turn-around and scheduling requirements and constraints; and extend models to include power and performance metrics as part of the wider knowledge base in forming an application signature-processor pairing that can be used to perform intelligent processor selection on a case-by-case basis.</p>			
<p><b><i>Title:</i></b> Network Science Technology Experimental Center</p> <p><b><i>Description:</i></b> Supports in-house Network Science studies in conjunction with the Network Sciences Collaborative Technology Alliance (PE 0601104A/Project H50).</p> <p><b><i>FY 2013 Accomplishments:</i></b> Developed and validated approaches and techniques to characterize, assess, model, and predict the performance of a notional composite network;examined the interaction of social, informational and communication processes as they adapt to changes in mission, adversarial attacks and changes in tactics, and structure. The results contributed to the development of tools to equip Warfighters with the capability to anticipate and manage the effects of information, social and communication dynamics on tactical networks for mission command.</p> <p><b><i>FY 2014 Plans:</i></b> Examine the interaction of social, informational and communication processes as they adapt to changes in mission, adversarial attacks and changes in tactics, and structure; begin designing and developing composite trust management techniques and metrics that consider the interactions between social, information and communication networks; and begin developing techniques to model a hybrid network (wired and wireless).</p> <p><b><i>FY 2015 Plans:</i></b> Expand the wireless emulation capabilities to include the interactions among communication, social, and information networks; continue to develop techniques for modeling the performance of hybrid networks; and develop, analyze and validate composite</p>		5.849	6.120
			5.220

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> H48 / Battlespace Info & Comm Rsc	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
trust management techniques and metrics that consider the interactions between social, information and communication networks. These efforts will provide improved understanding of tactical network behaviors, improved network designs, secure information flows and enhanced decision-making.			
<b>Title:</b> Quantum Information Sciences  <b>Description:</b> Perform research to enable new techniques for ultra-precise navigation, timing, communications and imaging using atomitronics and spintronics (quantum measurement and sensing devices based upon atoms and spin, respectively, instead of electrons). Conventional techniques for sensing magnetic fields, gravity, and timing have reached a plateau in their performance, and will be severely impacted in future contested-battlefield environments. This research brings forth new insights regarding the use of quantum science to enhance Warfighter effectiveness.  <b>FY 2015 Plans:</b> Will study physics of compact (wrist-watch scale) atom chips (an atom chip uses quantum properties of atoms to sense gravity and acceleration) needed for a precise position/navigation/timing (PNT) sensor; study fundamental atomic physics of quantum repeaters, for an eventual hybrid quantum communication system, based on transmission of single photons that are quantum mechanically entangled with quantum memories; and obtain new insights into "writing" and "reading" laser-cooled rubidium atoms to store and later retrieve a single photon from the atomic ensemble over long haul optical fiber.		-	-
<b>Accomplishments/Planned Programs Subtotals</b>		19.563	21.545
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b> N/A			
<b>E. Performance Metrics</b> N/A			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) H52 / Equip For The Soldier			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H52: Equip For The Soldier	-	1.056	1.146	1.103	-	1.103	1.124	1.137	1.156	1.179	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
Note Not applicable for this item												
A. Mission Description and Budget Item Justification												
This project supports basic research to achieve technologies for the Soldier of the future which focus on core technology areas that include mathematical modeling, physical and cognitive performance, polymer science/textile technology, nanotechnology, biotechnology, and combat ration research. The research effort is targeted on enhancing the mission performance, survivability, and sustainability of the Soldier by advancing the state-of-the-art in the sciences underlying human performance, clothing, and protective equipment to defend against battlefield threats and hazards such as ballistics, chemical agents, lasers, environmental extremes, and ration shortfalls.												
Work in this project provides theoretical underpinnings for PE 0602786A (Warfighter Technology).												
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 is performed and managed by the Natick Soldier Research, Development, and Engineering Center (NSRDEC), Natick, MA.												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2013	FY 2014	FY 2015	
Title: Equipment for the Soldier									1.056	1.146	1.103	
Description: This project supports basic research to achieve technologies for the Soldier of the future which include mathematical modeling, physical and cognitive performance, polymer science/textile technology, nanotechnology, biotechnology, and combat ration research.												
FY 2013 Accomplishments: Explored different methods to extract a concise feature vector to describe the shape of the human body: implemented computational algorithms to extract the shape-vectors of three-dimensional (3D) scans from the US Army and Marine Corps 3D scan database; made modifications to available models to reflect the material dependencies on vapor concentration and solubility to understand experimental transport data for constituent membranes and laminates and linear permeation models.												
FY 2014 Plans:												

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p>Explore the permeation phenomena of multilayer films leading to improved barrier properties for the myriad needs for effective polymer films; investigate the cognitive foundations of spatial navigation for route planning through complex environments; continue to explore the aerodynamics and structural behavior of permeable structures under dynamic loads for improving parachute performance.</p> <p><b>FY 2015 Plans:</b> Will examine thermal degradation mechanisms in selected natural materials as basis for potential flame/fire protection approaches; create nonwoven electrospun composites of unique composition and examine their properties and material behavior to provide foundation for robust, Soldier-based sensing of pathogens in food and ambient environment.</p>			
<b>Accomplishments/Planned Programs Subtotals</b>		1.056	1.146
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) H57 / Single Investigator Basic Research			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H57: Single Investigator Basic Research	-	69.342	80.342	81.245	-	81.245	87.862	89.077	88.046	93.767	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
Note Not applicable												
A. Mission Description and Budget Item Justification												
This project fosters extramural basic research to create and exploit new scientific discoveries and technology breakthroughs, primarily from universities, that will improve the Army's transformational capabilities. Current technologies are unable to meet the operational requirements of the future force. The Army Research Office of the Army Research Laboratory (ARL) maintains a strong peer-reviewed scientific research program through which leap-ahead technological solutions may be discovered, matured, and transitioned to overcome the technological barriers associated with next generation capabilities. Included are research efforts for increasing knowledge and understanding in fields related to long-term future force needs in the physical sciences (physics, chemistry and life sciences), the engineering sciences (mechanical sciences, electronics, materials science and environmental science (atmospheric and terrestrial sciences)), and information sciences (mathematical sciences, computing sciences, and network sciences). Targeted research programs in nanotechnology, training and simulation, smart structures, multifunctional and micro-miniature sensors, intelligent systems, countermeasure, compact power, and other mission-driven areas will lead to a future force that is more strategically deployable, more agile, more lethal, and more survivable. The breadth of this basic research program covers approximately 900 active, ongoing research grants and contracts with leading academic researchers and approximately 1,600 graduate students yearly, supporting research at nearly 250 institutions in 50 states.												
Work in this project supports key Army needs and provides the technical underpinnings to several Program Elements (PEs) to include PE 62618A (Ballistics Technology)/Project H80 (Survivability and Lethality 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 extramurally by the U.S. Army Research Laboratory (ARL), Adelphi, MD.												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2013	FY 2014	FY 2015	
Title: Basic Research in Life Sciences									7.768	8.190	8.300	
Description: Pursues fundamental discoveries in life sciences with the ultimate goal of facilitating the development of novel biomaterials to greatly enhance Soldier protection and performance. More specifically, i) molecular genetics research pursues fundamental studies in molecular and systems biology, and genetics, ii) neurosciences research investigating the physiology												

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p>underlying perception, neuro-motor output, and potential methods of monitoring cognitive states during activity, iii) biochemistry research focuses on studies in structural and cell biology, metabolic processes, and biophysics, iv) research in microbiology pursues studies in microbial physiology, ecology, and evolution, v) social science research aims to elucidate the social, cultural, and other influences to human actions, and vi) auditory and signal processing research to map the cognitive implications of multisensory information integration.</p> <p><b>FY 2013 Accomplishments:</b> Efforts studied fundamental genetic and physiological properties that impact human cognitive and physical performance under normal and stressed conditions; explored mechanisms that control the organization of biomolecules, and novel approaches to support biological activity outside of the cellular environment; elucidated mechanisms of microbial adaptation and antimicrobial resistance; studied the fundamental physiology underlying cognition and novel non-invasive methods to monitor cognitive processes; and explored the basic theoretical foundations of human behavior across various temporal and spatial scales.</p> <p><b>FY 2014 Plans:</b> Investigate the genetic plasticity of bacterial genomes during long-term stationary phase growth and develop an empirical understanding of the general mechanisms by which genomic (gene-based), transcriptomic (RNA-based), and proteomic (protein-based) prokaryotic features respond to alterations in the population-genetic environment, to ultimately enable accurate identification of the origin of biological threats; investigate and characterize sensory auditory processing to determine how Soldiers can separate several streams of sounds into meaningful sequences in order to develop algorithms to augment both natural and automated hearing in noisy and confused environments; assemble and characterize a synthetic biological receptor and signaling program within a bacterial strain capable of encapsulating itself within a natural cellulose filter, which may ultimately enable new chemical/biological detection applications; characterize the resolution of holographic microscopy for visualizing microbes based on recent discoveries in lens-less holographic imaging, which in the long term may replace optical microscopes, enabling low-cost, rugged microscopes for field use; and design and validate robust optimal social system interventions based on a more formal understanding of feedback mechanisms with the objective of avoiding failed negotiations, socio-economic crises and societal collapse.</p> <p><b>FY 2015 Plans:</b> Will identify the genetic networks and epigenetic factors that enable the survival of bacteria in extreme stress conditions, which may reveal new insight into stress resilience and survival in eukaryotic organisms, and ultimately enable the engineering of microorganisms better suited to rugged industrial production conditions; expand studies of previously-demonstrated DNA assembly method to determine whether diverse nanostructured shapes can be carved from a common three dimensional (3-D) DNA block, which may provide a future template for generating hybrid materials with the advantages of both biological and synthetic systems; characterize the molecular dynamics and evolution of associative memory in bacteria, which will be an important step towards understanding microbial adaptation potential for use as a potential tool to be exploited for microbial</p>			



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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
forensics analyses; and devise a model for the automated synthesis of neuro-cognitive computational models derived from brain activity to determine whether it is possible to mathematically link functional brain data to cognitive states, which could ultimately lead to new applications for assessing and improving Soldier mental performance such as battlefield training, and treatment of disorders such as post-traumatic stress disorder (PTSD).			
<b>Title:</b> Basic Research in Environmental Sciences  <b>Description:</b> Basic research in the environmental sciences is needed for the Army to operate effectively because terrestrial and atmospheric conditions and processes affect virtually all aspects of Army activities. The earth's surface environment is a multifaceted and dynamic system, and there is an increasing need for multidisciplinary approaches to address important research questions within the atmospheric and terrestrial sciences.  <b>FY 2013 Accomplishments:</b> Environmental sciences developed new approaches to improve the resolution and tradeoffs in high fidelity modeling of atmospheric and terrestrial physical processes; developed new approaches to spatially revise both theoretical and observational problems associated with the Monin-Obukhov theory; optimized and enhanced the performance of the sensor modalities used in unexploded ordnance (UXO), landmine, and explosive device detection; and developed constitutive models for near-surface processes.  <b>FY 2014 Plans:</b> Pursue atmospheric examinations in the convective boundary layer using vertically pointing clear-air doppler radars and sodars to measure mean vertical velocities; and improve estimates of soil moisture through a data assimilation approach that utilizes remotely sensed soil moisture information at coarse spatial resolution and combines it with a physics-based land surface process model to produce soil moisture estimates at the fine spatial scales of Army operational interest.  <b>FY 2015 Plans:</b> Will exploit recent theoretical and experimental advances in soft-matter physics to isolate and examine the granular dynamics of fluid-driven sediment transport, focusing on bed load transport in rivers.		3.028	3.774
<b>Title:</b> Basic Research in Chemical Sciences  <b>Description:</b> Basic research to achieve advanced energy control, improved threat detection, and novel responsive materials for Soldier protection. Research efforts will lead to: light-weight, reliable, compact power sources, more effective, lower vulnerability propellants and explosives for tailored precision strikes with minimum collateral damage, new approaches for shielding the Soldier and Army platforms from ballistic, chemical, and biological threats, and reducing signatures for identification by the enemy, and advance warning of explosive, chemical, and biological weapons and dangerous industrial chemicals.  <b>FY 2013 Accomplishments:</b>		8.640	9.418
			9.600

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p>Conducted research on ionic liquids in order to obtain an in-depth understanding of how their structure effects physical properties, such as transport, viscosity, and conductivity; explored series of switchable catalysts that are capable of altering their activities in response to changes in their oxidation states in an effort to produce precisely controlled microstructures; and explored covalently immobilized peptides and proteins on non-biological surfaces to understand how the bio/abio interface can be manipulated to promote desired biological structure and function.</p> <p><b>FY 2014 Plans:</b> Explore and characterize the reaction pathways for nitroaromatics and nitramines (classes of compounds that include explosives) to determine mechanisms by which these molecules undergo dissociation to initial product species; investigate nanoscale patterning of protein-based fibers on non-biological surfaces to understand how these surface properties can be manipulated to control the structure and function of biological molecules, and testing novel single-molecule probes to investigate proteins in near-surface environments at the molecular level, for potential long-term applications in chemical and biological defense; and investigate electrochemical systems utilizing new materials with controllable structures and chemical properties that may ultimately enable lighter, more efficient batteries or fuel sources.</p> <p><b>FY 2015 Plans:</b> Will investigate and characterize the ionic states of energetic compounds which will enable the design of safer (e.g. during transport and storage), more powerful explosives and propellants; identify fundamental mechanisms and properties that control the assembly and dissociation of supramolecular systems upon influence of external stimuli, such as toxic chemicals, enzymes, or changes in pH, which will ultimately lead to new capabilities for protection from, and inactivation of, chemical and biological warfare agents and toxic industrial chemicals; synthesize polymeric materials employing unique building motifs with the goal of creating a self-assembled complex ensemble - the ensemble's response to a variety of conditions will be used to determine how the state of the system can be controlled in a nonlinear manner, which may ultimately lead to new materials or coatings that can detect and repair defects; and probe transport processes in confined media to reveal an improved understanding of ion transport, which will provide new long-term applications such as fuel cell membranes with higher ionic conductivity to provide the Soldier with more effective portable power systems.</p>			
<p><b>Title:</b> Basic Research in Physics</p> <p><b>Description:</b> Focuses on research in many subfields of physics, including condensed matter physics, optical physics, atomic and molecular physics and quantum information, with an emphasis on discovering new realms of quantum and optical phenomena. Pursuit of fundamental physics in these subfields provides new opportunities for future developments in superior optics, ultra-sensitive sensors, and novel electronic architectures for classical and quantum computing.</p> <p><b>FY 2013 Accomplishments:</b></p>		10.953	12.281
			12.800

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
<p>Investigated quantum optics of metamaterials including exploration of fundamentally new quantum effects including the photon spin and the interaction with negative index materials; explored the control of light filaments and long distance propagation; continued attempts to demonstrate a 25 atto-second laser pulse; began studies of high intensity laser light; designed and tested alternative cooling techniques for use on molecules not amenable to traditional laser-cooling approaches; investigated protected states of matter in condensed matter as well as atomic and molecular systems; investigated non-equilibrium states in ultra-cold atomic optical lattices; implemented and characterized multi-qubit states; researched methodology for the rational design of novel quantum many-body states in complex oxide heterostructures; identified the defect tolerance in a series of complex oxides; performed in-situ chemical analysis of complex oxides; and identified and characterized new candidate materials for topological insulators with strong electronic interactions.</p> <p><b>FY 2014 Plans:</b> Investigate dynamics of thermally-isolated systems in atomic systems which will facilitate the future engineering of new materials with dynamic properties for the future warfighter; design and demonstrate laser-plasma beams using ultra-short pulsed lasers and investigate the unique light-propagation characteristics in the atmosphere not possible with conventional lasers, which may ultimately enable standoff detection of explosive residue; explore high-intensity lasers as a method for creating gamma ray beams that may ultimately obviate the need for conventional large, expensive, immobile, reactors or extremely hazardous reactive materials; design and explore quantum systems, such as nitrogen in synthetic diamond, for low-power high-precision sensing and imaging exceeding the capabilities of current classical systems; design and synthesize topological insulators (e.g., a novel type of material that changes electrical properties based on its three-dimensional structure); and discover and characterize the properties of these new topological insulators under varying magnetic and electrical conditions, which may enable new ultra-sensitive detectors and ultra-low power electronics.</p> <p><b>FY 2015 Plans:</b> Will explore the infrared and optical responses of electrostatically-induced effects in correlated oxides, such as metal-to-insulator transitions, which may lead to advanced electronic technologies for sensing and computational hardware; investigate new synthetic physics in cold quantum gases, which will ultimately contribute to the development of cold-atom interferometers for ultra-accurate navigation and quantum computing applications for secure communication; detect single molecular ion spectra using laser-cooled atomic ions by exploiting previous research on trapped ions for quantum information science, which may ultimately lead to capabilities beyond what is possible with classical systems, such as resource optimization, optimal wargaming, efficient and secure command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR) that will greatly benefit the DoD, airline, financial, and telecommunications industries; demonstrate and characterize microjoule-level laser pulse energies for 150 attosecond pulses in the 30-70 eV photon energy range (&gt;1,000 times higher than the current world record), which may enable future applications in standoff explosives detection and sensing through obscurants.</p>				
Title: Basic Research in Electronics and Photonics		9.854	10.905	11.500

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p><b>Description:</b> Pursues discoveries in electronic sensing, optoelectronics, solid state and high frequency science, electromagnetics, microwaves, and power electronics for situational awareness, communications, information processing, electro-magnetic warfare, and power efficiency.</p> <p><b>FY 2013 Accomplishments:</b> Synthesized mercury cadmium selenide on gallium antimonide substrates and investigate its optical and structural characteristics for infrared detection; developed novel vertical cavity transistor lasers with high modulation rates; developed biologically-inspired RF direction finding antenna arrays and associated signal processing techniques based on the operation of the human auditory system; and investigated nanoscale constructs within cells and engineered nano-structures.</p> <p><b>FY 2014 Plans:</b> Improve optical quality and coherency of mid infrared lasers to facilitate free space optical communications, ladar and infrared countermeasures; show feasibility of semiconductor-less infrared detection that utilizes electron tunneling; explore time-frequency and non-laplacian phenomena to understand and extend the fundamental performance limits of radio, radar, and electronic warfare systems; and develop terahertz frequency photomixing arrays with 10x improvement in output powers to enable the remote detection of chemical, biological and explosive threats.</p> <p><b>FY 2015 Plans:</b> Will show independent tuning of the temperature coefficient of resistance and noise in bolometers to improve signal to noise ratio of room temperature infrared detectors; show electrically injected, high-speed 1.55 µm nanoscale lasers on a silicon (Si) platform for potential gains in energy efficiency of computational and sensor systems; show that plasmonic antennas can mitigate efficiency degradation of conventional antennas at terahertz and optical frequencies to investigate the potential of free-space interconnects for efficient data communications and energy harvesting; and create and investigate a novel sensor based on optical dark modes in nanorods for use in biomolecule, chemical sensing, and near-field imaging.</p>			
<b>Title:</b> Basic Research in Materials Sciences		6.333	7.067
<p><b>Description:</b> Research that provides innovations in materials design and process through the elucidation of fundamental relationships linking composition, microstructure, defect structure, processing and properties of materials. Revolutionary materials provide support for the Army in firepower, mobility, communications, personnel protection, infrastructure and installations, and will directly affect virtually all mission areas. In FY13, the Mechanical Sciences research description and associated funding moved to the Mechanical Sciences section within this Project.</p> <p><b>FY 2013 Accomplishments:</b> Demonstrated novel materials with large electro-caloric effects for thermal management; achieved rapid fabrication and densification of nanostructured materials with unique combinations of high-pressure and electrical field; established theory to</p>		7.200	

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
guide the design and fabrication of multifunctional materials incorporating programmable responses and hierarchical constructs; fabricated novel three dimensional (3-D) topological insulators with unsurpassed bulk resistivity and surface electron mobility; and demonstrated the ability to translate biochemical activity onto inorganic surfaces.			
<b>FY 2014 Plans:</b> Establish the use of resonant optical effects to achieve size sorting of microspheres in solution with unprecedented precision; demonstrate a new class of materials for low power sensing based on variable temperature conduction; provide a robust computational methodology to predict the relationships between a material's electronic structure, its local elastic properties, and its composition for the vast majority of transition metal critical points; and fabricate novel fully transparent materials with record hardness and toughness for advanced protection.			
<b>FY 2015 Plans:</b> Will elucidate the molecular mechanisms by which living cells regulate intracellular biochemical activity with mechanical force and design novel materials with force-activated control; provide novel functional materials with unprecedented physical properties through strongly linked multi-scale models developed specific to the materials systems; and complete a vigorous investigation of two-dimensional non-graphitic atomic layers and heterostructures and identify advanced material properties and capabilities.			
<b>Title:</b> Basic Research in Computing Sciences		5.518	7.724
<b>Description:</b> Provides the backbone for performing complex, multi-system analysis, modeling and simulation for understanding information systems. Advancements in computer sciences have a direct impact on enhancing the Warfighters' decision-making, situation awareness, command and control, as well as on the overall performance of weapon, intelligence, transportation and logistics systems. In FY13, the Mathematical Sciences research description and associated funding moved to the Mathematical Sciences section within this Project.			8.145
<b>FY 2013 Accomplishments:</b> Continued to explore and investigate new effective computing architectures, computational methods and software tools; developed new methods for data sensing and fusion over large volumes of social data; and continued long term efforts to develop methods for the tomography of social networks, for predicting individual and collective human behaviors in the war against terrorism, and developed structural methods for automatic machine translation.			
<b>FY 2014 Plans:</b> Explore robust computational methodologies for large dataset processing and analysis with optimized data representations, and obtain optimal realization of Real-Time Multi-core Systems to support complex, resource-demanding, real-time Intelligence, Surveillance, and Reconnaissance (ISR) applications; create new image data feature analysis and pattern classification methods			

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>
for object detection, recognition, and long-term tracking under challenging dynamic conditions; and develop quantification and metrics for effective analysis of social-interaction phenomena for better prediction of unusual social events in asymmetric defense.				
<b>FY 2015 Plans:</b> Will establish new knowledge in acquiring, computing, and analyzing big data in a trusted fashion, and investigate novel techniques for processing multi-modal data that may be in the form of text, photo, video, and audio so that actionable intelligence and timely information can be extracted and derived for better situation awareness and better decision making; investigate new concepts such as value of information, and invest in new research opportunity areas such as social informatics; and pursue efforts on information assurance with a special focus on hardware based resilient techniques.				
<b>Title:</b> Basic Research In Network Sciences  <b>Description:</b> Focuses on gaining an understanding of the fundamental aspects of how networks develop, function, and adapt to the environment and the rate of information flow in manmade and naturally occurring networks. This understanding will have a direct impact on net-centric force operations, such as better communication system design and operations, and more efficient logistics or communications support.		5.912	8.260	8.400
<b>FY 2013 Accomplishments:</b> Evaluated mathematical models of how information spreads through groups/networks using a Behavioral Game Theory framework; developed mathematical models of decision making using neuroscience experiments in collaboration with Life Sciences, with attention being paid to errors in human judgment; and investigated game theory derived from observational data to understand microbe adaptations and micro-scale locomotion and control for micro-bio-robots.				
<b>FY 2014 Plans:</b> Explore the notion of a tipping point (e.g., when a society changes its views) from a Statistical Mechanics perspective and from a Behavioral Game Theory perspective, with attendant efforts to reconcile the two views; continue mathematical modeling of neuronal structures informed by experiments to grow neurons and extend to capture cognitive intelligence that arises from networks of neurons; study games derived from observation with respect to equilibrium and robustness properties and validate on problems related to reasoning about adversarial networks; and study the effect of human networks on communication networks with the goal of finding effective bandwidth/spectrum/resource utilization.				
<b>FY 2015 Plans:</b> Will study interconnected networks and how failure in a network spreads to other networks; investigate rigorous mathematical theories that bring together statistical mechanics, operations research, game theory and reliability theory that could predict how failures propagate and when/how failures could be controlled; explore new game theory inspired models for how economic and social factors lead to large societal changes, such as Arab spring style revolutions; and study tensor decomposition of spectral				

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B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
graphs that arise from big data in social networks with a view towards automatically learning the structure of networks and their properties.				
<p><b>Title:</b> Basic Research in Mechanical Sciences</p> <p><b>Description:</b> Focuses on improved understanding of propulsion and combustion for improved efficiency and fuel flexibility, energetics initiation for insensitive munitions, fluid dynamics for rotorcraft, complex dynamic systems for novel sensors, energy generation and multi-dimensional systems, and solid mechanics especially at high strain rates in composite materials for novel armor and protection systems.</p> <p><b>FY 2013 Accomplishments:</b> Established the differential geometry (geometric mechanics) of multi-body/granular media interactions; developed an understanding to enable JP-8 surrogate fuels for diesel engine cycle studies; investigated novel nano-thermodynamic corrections for prediction of hot spots in energetic material; and investigated the flow mechanisms associated with transitory aerodynamic loading affected by flow control on the boundaries of stationary and moving platforms.</p> <p><b>FY 2014 Plans:</b> Conduct counter-flow burner studies for investigating high molecular weight hydrocarbon fuel and jet fuel chemistry at elevated pressures up to 2.5MPa; investigate novel transparent fully cross-linked Molecular Interpenetrating Polymer Composites (MIPCs) under high strain rate loading conditions; develop a new representation of the Navier-Stokes equations providing rapid convergence when compared to existing solvers for equivalent flow field models, grid types and grid sizes; and elucidate the fundamental physical interactions responsible for energy dissipation and quality factor magnification within prototypical nano-electromechanical systems.</p> <p><b>FY 2015 Plans:</b> Will gain understanding of oxidizer behavior in energetic materials via determination of how the morphology and phase behavior is evolving during the heating and reaction process; will demonstrate new capabilities to actively control entropy production and free energy exchange in arrays of molecular motors; develop a reduced-order methodology suitable for the study of the large parameter design space associated with "dynamic stall"; and develop a numerical modeling approach capable of quantifying the formation of shear bands and dynamic crack propagation of structural materials under high strain rate loading.</p>		5.649	6.445	6.700
<p><b>Title:</b> Basic Research in Mathematical Sciences</p> <p><b>Description:</b> Pursue the creation of new mathematical tools and methods for performing complex, multi-system analysis and modeling to enhance soldier and weapon-system performance. More specifically, the focus is on creating mathematical principles and practical algorithms for stochastic analysis and control, analysis and control of biological systems, numerical computation of infinite-dimensional systems and modeling of irregular geometric and social phenomena.</p>		5.687	6.278	6.600

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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p><b>FY 2013 Accomplishments:</b> Created new numerical methods and algorithms that facilitate improved aerodynamic performance of helicopters in adverse conditions as well as enabled optimal design of supersonic projectiles; continued to develop a multivariate heavy-tail statistical theory and developed algorithms to improve modeling capability for complex systems; and created new mathematical tools, computational algorithms, and capabilities that deepens understanding of protein-ligand docking.</p> <p><b>FY 2014 Plans:</b> Conduct innovative basic research in statistical analysis, commutative and quantum stochastics and control, multiscale computational methods, computational cell and molecular biology and fundamental laws of biology in order to revolutionize methodologies for information assurance, counter-terrorism, next generation communication networks, weapon design, testing, and evaluation, and coordination and collective decision-making.</p> <p><b>FY 2015 Plans:</b> Will conduct innovative basic research in statistical analysis, infinite-dimensional stochastics and control, multiscale procedures that transfer information among multiple sets of scales, identification and quantification of fundamental principles of biological dynamics often through multiscale modeling, representation of three dimensional (3-D) terrain and new metrics for small-group social and sociolinguistic phenomena. This mathematical sciences research will lead to improved conventional and quantum information networks and information processing, soldier health and performance, decision making, training, simulation and mission planning.</p>			
<b>Accomplishments/Planned Programs Subtotals</b>		69.342	80.342
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			



# UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) H66 / Adv Structures Rsch			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H66: Adv Structures Rsch	-	1.853	2.017	2.006	-	2.006	2.044	2.068	2.102	2.142	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
Note Not applicable for this item												
A. Mission Description and Budget Item Justification												
<p>This project funds basic research for improved tools and methods to enable the structural health monitoring capabilities and condition-based maintenance for rotorcraft and ground vehicles. This research also enables the design and use of composite structures that can better address the cost, weight, performance, and dynamic interaction requirements of future platforms identified by the Army Modernization Strategy. Ultimately, these technologies result in safer, more affordable vehicles with a greatly reduced logistics footprint. This project is a joint Army/NASA effort that includes structures technology research into: structural integrity analyses; failure criteria; inspection methods which address fundamental technology deficiencies in both metallic and composite Army rotorcraft structures; use of composite materials in the design and control of structures through structural tailoring techniques; rotorcraft aeroelastic modeling and simulation; helicopter vibration (rotating and fixed systems); and the design and analyses of composite structures with crashworthiness as a goal. The problems in structural modeling are inaccurate structural analysis and validation methods to predict durability and damage tolerance of composite and metallic rotorcraft structures and inadequate structural dynamics modeling methods for both the rotating and fixed system components to address reliability issues for future aircraft. The technical barriers include a lack of understanding of failure mechanisms, damage progression, residual strength, high-cycle fatigue, the transfer of aerodynamic loads on the rotor to the fixed system, and impact of these unknown loads on aircraft components. Technical solutions are focused on: advanced fatigue methodologies for metallic structures, improved composites technology throughout the vehicle, long-term investigation of integrated stress-strength-inspection, advanced methods for rotor system vehicle vibratory loads prediction, improved methods to predict vehicle stability, and improved analyses to address Army Aviation requirements. These advancements will extend service life, reduce maintenance costs, enhance durability, and reduce the logistics footprint of existing and future Army vehicles. This is the only basic research project supporting investigations for rotorcraft and ground vehicle structures within the Department of Defense.</p> <p>Work in this project supports key Army needs and provides the technical underpinnings to Program Element (PE) 0602211A (Aviation Technology).</p> <p>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.</p> <p>Work in this project is performed by the U.S.Army Research Laboratory (ARL), using facilities located at NASA Langley Research Center, Hampton, VA, and at Aberdeen Proving Ground, MD.</p>												
B. Accomplishments/Planned Programs (\$ in Millions)												
Title: Structural Analysis and Vibration Methods									FY 2013	FY 2014	FY 2015	
									1.853	2.017	2.006	

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> H66 / Adv Structures Rsch	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p><b>Description:</b> This research explores new structural analyses and validation methods to achieve more accurate predictions of durability and damage tolerance in composite and metallic rotorcraft structures and evaluates structural dynamics modeling methods to address critical reliability issues in the rotating and fixed system components of future aircraft.</p> <p><b>FY 2013 Accomplishments:</b> Validated progressive failure analysis methods and fatigue damage model of composites under various loadings and composite configurations to address failures in Army vehicle composite structures; assessed sensor technologies embedded in composite materials to enable multifunctional structures and to improve the capability to predict the remaining useful life of Army vehicle structures; investigated an advanced sensing method used for prognostics and diagnostics to reduce maintenance man-hours and to increase the availability of Army weapon systems.</p> <p><b>FY 2014 Plans:</b> Investigate adaptive seat damper materials and strategies for improved vibration reduction over a variety of terrains and for different gross vehicle weight configurations; develop and demonstrate a virtual testing capability for lightweight composite structures by integrating probabilistic methods, which are reliant on current and historical data, into existing physics-based models; develop signal processing algorithm for tracking damage transients; and investigate three-dimensional printing of novel multifunctional materials for micro air and ground vehicle applications.</p> <p><b>FY 2015 Plans:</b> Will investigate strategies for improvement of durability of vehicle platforms through the introduction of novel composite materials; develop and demonstrate a probabilistic tool for the development of novel composite materials to address specific structural performance requirements; develop the capability to capture and quantify precursors to damage in structural components that will enhance the operation and sustainability of future vehicle systems; and demonstrate three-dimensional printing of multifunctional structural components for air and ground vehicle applications.</p>			
<b>Accomplishments/Planned Programs Subtotals</b>		1.853	2.017
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b> N/A			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES	Project (Number/Name) H66 / Adv Structures Rsch
E. Performance Metrics N/A		

**UNCLASSIFIED**

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) H67 / Environmental Research			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H67: Environmental Research	-	0.935	1.030	0.903	-	0.903	0.920	0.931	0.946	0.965	-	-

# The FY 2015 OCO Request will be submitted at a later date.

**A. Mission Description and Budget Item Justification**

This project focuses basic research on innovative technologies for industrial pollution prevention (P2) that directly supports the Army production base and weapon systems and addresses non-stockpile chemical warfare (CW) site remediation. Work in pollution prevention invests in next generation manufacturing, maintenance, and disposal methods that will result in significantly reducing the usage of hazardous and toxic substances and their associated costs. The goal is to decrease the overall life-cycle costs of Army systems by 15-30% through the application of advanced pollution prevention technologies. The CW remediation efforts concentrate on the application of biotechnology in the characterization and physical clean up of agent contaminated soils and groundwater and reduced corrosive and more environmentally benign decontamination of biological warfare (BW) agents on field equipment and weapon systems, with the goal of reducing the cost of remediating a site by at least 50% versus the use of conventional methods. CW thrusts include establishing the ecotoxicity of CW compounds, environmental fate and effect of CW compounds in soils and biodegradation of CW compounds. Pollution prevention thrusts include: environmentally acceptable, advanced, non-toxic processes to manufacture lightweight alternative structural materials to enhance weapon system survivability; clean synthesis of more powerful and improved energetic compounds to eliminate the use of hazardous materials and minimize the generation of wastes; and surface protection alternatives to hazardous paints, cadmium, chromium, and chromate conversion metal and composite surfaces.

Work in this project complements and is fully coordinated with the Army Environmental Requirements Technology Assessment (AERTA) requirements. The program element contains no duplication with any effort within the Military Departments.

The cited work provides the technical underpinnings for PE 0602618A (Ballistics Technology).

Work in this project is performed by the U.S. Army Armament, Research, Development and Engineering Center, Picatinny, NJ.

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

	<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>
<b>Title:</b> Industrial Pollution Prevention	0.935	1.030	0.903
<b>Description:</b> This effort conducts research on innovative environmentally-friendly technologies that support the warfighter (focusing on pollution prevention technologies).			
<b>FY 2013 Accomplishments:</b> Conducted research on mechanics of antibiotic and disinfectant resistance from wastewater treatment and research into synthesis of biofuels.			
<b>FY 2014 Plans:</b>			

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> H67 / Environmental Research	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
Research gasification/biofuels technology, green technologies for energetic/propellants to eliminate hazardous materials, next generation of bio-based materials from sustainable resources and microbial resistance to disinfectants.			
<b>FY 2015 Plans:</b> Will research green technologies for new energetics/propellants, airborne lead reduction in Army weapon systems, and environmentally friendly technologies to support Army soldier systems; will select projects to support the Army Environmental Requirements and Technology Assessments (AERTA).			
<b>Accomplishments/Planned Programs Subtotals</b>		0.935	1.030
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b> N/A			
<b>E. Performance Metrics</b> N/A			

# UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) S13 / Sci BS/Med Rsh Inf Dis			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
S13: Sci BS/Med Rsh Inf Dis	-	11.172	10.696	11.005	-	11.005	11.248	11.378	11.560	11.789	-	-

# The FY 2015 OCO Request will be submitted at a later date.

## A. Mission Description and Budget Item Justification

This project fosters basic research leading to medical countermeasures for naturally occurring diseases impacting military operations. Basic research for this project provides an understanding of the mechanisms that make organisms infectious and mechanisms that render the human body response effective to prevent diseases caused by infectious agents. Understanding the biological characteristics of infectious organisms also enables the development of point-of-care and laboratory-based diagnostic tools (use for the identification of the nature and cause of a particular disease). Understanding of disease transmission by insects and other organisms helps in developing new interventions to prevent transmission of such diseases. Infectious disease threats from malaria, diarrhea, and dengue (a severe debilitating disease transmitted by mosquitoes), which are common in Africa, Central, European, Southern, and/or Pacific Commands, are the highest priorities for basic research.

Research conducted in this project focuses on the following five areas:

- (1) Prevention/Treatment of Parasitic (organism living in or on another organism) Diseases
- (2) Vaccines for the Prevention of Malaria
- (3) Bacterial Disease Threats
- (4) Viral Disease Threats
- (5) Diagnostics and Disease Transmission Control

Work is managed by USAMRMC in coordination with the Naval Medical Research Center (NMRC). The Army is responsible for programming and funding all Department of Defense naturally occurring infectious disease research requirements, thereby precluding duplication of effort within the Military Departments.

Work in this project complements and is fully coordinated with PE 0602787A (Medical Technology).

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) and NMRC, Silver Spring, MD, and their overseas laboratories.

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

	<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>
<b>Title:</b> Prevention/Treatment of Parasitic (organism living in or on another organism) Diseases	3.521	3.810	3.900

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> S13 / Sci BS/Med Rsh Inf Dis	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p><b>Description:</b> This effort conducts basic research to better understand the biology of malaria and leishmaniasis (a skin-based disease transmitted by sand flies) parasites and to gain the necessary foundation for discovering medical countermeasures to protect military personnel from infection. Malaria, which can cause fatal and chronic disease, is the most significant military infectious disease threat. Because the malaria parasite becomes resistant to drugs over time, it is necessary to continually search for parasite weaknesses that can be exploited with new, effective drugs and vaccines.</p> <p><b>FY 2013 Accomplishments:</b> Modified candidate compounds active against malaria and Leishmania parasites to improve their anti-parasitic activity with a goal to transition these compounds to pre-clinical studies in an animal model.</p> <p><b>FY 2014 Plans:</b> Optimize candidate anti-parasitic drugs by chemically modifying them to improve their safety, efficacy, and bio-availability. These modified compounds will be evaluated in animal models for down-selection of best compounds of interest.</p> <p><b>FY 2015 Plans:</b> Will continue to identify new lead candidate drugs and combinations to stay ahead of emerging drug resistance in malaria parasite. Will identify new technologies to deliver drugs into the human body by using novel formulations.</p>			
<p><b>Title:</b> Vaccines for Prevention of Malaria</p> <p><b>Description:</b> This effort conducts basic research to better understand and identify new proteins in the design of candidate vaccines for various types of malaria including the severe form of malaria (<i>Plasmodium falciparum</i>) and the less severe but relapsing form (<i>Plasmodium vivax</i>). A highly effective vaccine could reduce/eliminate the use of antimalarial drugs and also reduce the development of drug resistance to current/future drugs.</p> <p><b>FY 2013 Accomplishments:</b> Formulated and evaluated newly identified vaccine candidates and assessed mechanisms of protection in animal models and compared novel formulations of malaria vaccines for protective effectiveness in animal models.</p> <p><b>FY 2014 Plans:</b> Assess immunogenicity (immunity or an immune response) and protective effectiveness of new vaccine candidates in small-animal models to determine suitability in formulations of multiple antigen vaccines (an antigen is a substance, usually a protein, on the surface of a cell or bacterium that stimulates the production of an antibody).</p> <p><b>FY 2015 Plans:</b> Will identify and characterize mechanism of protective immunity. Will continue to assess immunogenicity (immunity or an immune response) of new vaccine candidates in small-animal models to determine suitability in formulations of multiple antigen vaccines</p>		2.331	2.307
			2.500

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PE 0601102A: DEFENSE RESEARCH SCIENCES  
Army



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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014		
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES	Project (Number/Name) S13 / Sci BS/Med Rsh Inf Dis		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
<p>Studied and evaluated the basis of dengue disease and how the immune system reacts to it; evaluated factors that contribute to causing dengue hemorrhagic fever that occurs in a subset of infected individuals only; developed methods of distinguishing between protective and non-protective antibodies that will be used as surrogate markers of protection when evaluating vaccines against dengue infection; determined the contribution of various cells present in human body to provide protection against dengue infection and/or dengue disease; studied and evaluated pathogenesis of hemorrhagic fever caused by hantaviruses (a family of deadly viruses transmitted by rodents); and studied the biology of HIV to understand the impact of human genes on HIV acquisition and progression to inform vaccine development.</p> <p><b>FY 2014 Plans:</b> Study the role of human cells and antibodies to develop medical countermeasures to prevent and/or treat diseases caused by hantaviruses (a deadly virus responsible of hemorrhagic fever with renal syndrome) and dengue; conduct epidemiological studies (study of the causes and transmission of disease within a population) to determine the prevalence and incidence of dengue fever and dengue hemorrhagic fever over time in diverse populations; and use the epidemiological information to develop and/or maintain vaccine test site infrastructure for the purpose of evaluating promising dengue vaccine candidates for safety and effectiveness.</p> <p><b>FY 2015 Plans:</b> Will identify and evaluate the role of human cells and antibodies in developing preventive and/or treatment countermeasures for diseases caused by hantaviruses (a deadly virus responsible of hemorrhagic fever with renal syndrome). Will identify host and viral determinants of dengue disease severity. Will explore innovative vaccine designs, adjuvant (agent that enhances the effect of vaccines) systems, and delivery methods for dengue virus vaccine. Will continue epidemiological (area of medicine that deals with the study of the causes, distribution and control of disease in populations) studies with all types of dengue present world-wide to determine the prevalence and incidence of dengue fever (a severe debilitating disease caused by a virus and transmitted by a mosquito) and dengue hemorrhagic fever (a life-threatening form of the dengue fever caused by a virus and transmitted by a mosquito).</p>				
<p><b>Title:</b> Diagnostics and Disease Transmission Control</p> <p><b>Description:</b> This effort conducts research to investigate the biology of biting insects (including mosquitoes and leishmaniasis-infected sand flies) and other organisms that transmit disease (disease vectors) and their control. This effort also expands medical diagnostic and disease surveillance capabilities in the field. This research will help to direct new interventions into preventing disease transmission.</p> <p><b>FY 2013 Accomplishments:</b></p>		1.633	1.471	1.467

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> S13 / Sci BS/Med Rsh Inf Dis	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p>Identified novel fast-acting, directly targeted, insecticides that rapidly degrade to harmless by-products; investigated next-generation risk assessment tools for evaluating potential infectious disease transmission in insects (beyond modeling); and developed identification keys for medically important insect vectors.</p> <p><b>FY 2014 Plans:</b> Develop identification keys for the medically important arthropod (e.g., ticks, mosquitos, and sandflies) vectors in alternative geographic areas not previously studied but potentially deployable locations and evaluate new technologies selected as part of the new-generation diagnostic systems for use in the deployed setting for detection of pathogens in humans.</p> <p><b>FY 2015 Plans:</b> Will explore innovative technologies (traps, attractants, and devices) for vector (organisms that transmit disease) surveillance in military operations. Will continue to develop user friendly, web-based, geographical identification keys for the medically relevant arthropods and insects (e.g., ticks, mosquitoes, and sandflies). Will identify novel pesticide matrices/application strategies for vector control. Will explore passive arthropod repellent systems/strategies that do not require pesticide applications.</p>			
<b>Accomplishments/Planned Programs Subtotals</b>		11.172	10.696
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			

# UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) S14 I Sci BS/Cbt Cas Care Rs			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
S14: Sci BS/Cbt Cas Care Rs	-	8.794	9.167	10.553	-	10.553	9.827	9.970	10.141	10.325	-	-

# The FY 2015 OCO Request will be submitted at a later date.

## A. Mission Description and Budget Item Justification

This project supports basic research to understand the fundamental mechanisms of severe trauma to advance treatment and surgical procedures to save lives and improve medical outcomes for the Soldier. Experimental models are developed to support in-depth trauma research studies. This project includes studies of predictive indicators and decision aids for life-support systems, studies to heal and repair burned or traumatically injured tissue, traumatic brain injury (TBI), sight and face trauma, and transplant technology. Such efforts will minimize lost duty time from and provide military medical capabilities for far-forward medical/surgical care of injuries, as well as post-evacuation restorative and rehabilitative care.

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) TBI
- (5) Clinical and Rehabilitative Medicine

Work in this project complements and is fully coordinated with PE 0602787A (Medical 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 WRAIR, Silver Spring, MD; the U.S. Army Dental Trauma Research Detachment (USADTRD) and the U.S. Army Institute of Surgical Research (USAISR), Fort Sam Houston, TX; and the Armed Forces Institute of Regenerative Medicine (AFIRM), Fort Detrick, MD.

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) TBI
- (5) Clinical and Rehabilitative Medicine

Work in this project complements and is fully coordinated with PE 0602787A, Project 874.

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014		
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES	Project (Number/Name) S14 / Sci BS/Cbt Cas Care Rs		
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 WRAIR, Silver Spring, MD; the U.S. Army Dental Trauma Research Detachment and the U.S. Army Institute of Surgical Research (USAISR), Fort Sam Houston, TX; and the Armed Forces Institute of Regenerative Medicine (AFIRM), Fort Detrick, MD.				
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
<p><b>Title:</b> Damage Control Resuscitation</p> <p><b>Description:</b> This effort conducts studies of genetic pathways and metabolic (biochemical activity) mechanisms associated with blood clotting to understand the relationships between the human immune processes and bleeding in trauma.</p> <p><b>FY 2013 Accomplishments:</b> Conducted studies aimed at reducing effects on cells caused by hemorrhage (bleeding) in an animal model during resuscitation to determine the role of an enzyme in protecting cells.</p> <p><b>FY 2014 Plans:</b> Conduct studies of re-engineered blood products to control traumatic bleeding and treat shock and perform studies to better understand the genetic basis of survival from hemorrhage.</p> <p><b>FY 2015 Plans:</b> Will conduct studies of cell and tissue protective drugs as potential new candidate alternatives to blood products and fluids when these are not available.</p>		1.295	1.617	2.700
<p><b>Title:</b> Combat Trauma Therapies</p> <p><b>Description:</b> This effort conducts studies of trauma to tissues and organs and ways to mitigate and/or repair this damage. Research addresses cellular repair/growth mechanisms to treat TBI, dental (facial and oral) injuries, extremity wounds and fractures, and burns.</p> <p><b>FY 2013 Accomplishments:</b> Continued to study the relevant model of bone defect to create a model for use in evaluating new therapies and identify factors capable of minimizing the development of chronic inflammation.</p> <p><b>FY 2014 Plans:</b> Study mechanisms to manipulate the molecules, cells, and structure of the skin to optimize healing, appearance, and function.</p> <p><b>FY 2015 Plans:</b></p>		0.767	0.783	0.800

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
Will begin studies to determine the optimal thicknesses of skin grafts for more rapid closure and improved functional outcomes of face wounds.			
<b>Title:</b> Combat Critical Care Engineering <b>Description:</b> This effort conducts basic science studies of vital sign responses to trauma as predictors of medical outcomes and as a basis for developing life-saving interventions. <b>FY 2013 Accomplishments:</b> Continued studies to investigate differences in physiological responses between individuals with high- and low-tolerance to blood loss as a path to tailoring resuscitation to individuals. <b>FY 2014 Plans:</b> Perform research on decision support algorithms that use non-traditional vital signs to assess patient physiologic status and continue studies of algorithms for early identification of individuals with high- and low-tolerance to blood loss to optimize resuscitation. <b>FY 2015 Plans:</b> Will continue research on decision support algorithms using non-traditional vital signs to assess patient status and optimize fluid resuscitation. Will conduct studies to identify new physiological (characteristic of or appropriate to an organism's healthy or normal functioning) information that distinguish individuals with high and low tolerances to blood loss.		0.629	0.857
<b>Title:</b> Traumatic Brain Injury <b>Description:</b> This effort conducts basic research in poly-trauma (multiple injuries)/Traumatic Brain Injury (TBI) model, cellular mechanisms of cell death, and the discovery of novel drugs and medical procedures to mitigate the effects of TBI. <b>FY 2013 Accomplishments:</b> Conducted research to further understand cell death and neuroprotection (protecting degeneration of the nervous system) mechanisms, and identified critical thresholds for secondary injury (i.e., polytrauma) complicating TBI. <b>FY 2014 Plans:</b> Apply systems biology metrics to models of mild and severe TBI to aid in discovery of novel proteins in the blood that appear as a result of traumatic injury, which may aid in diagnosis of TBI; perform basic research to study the brain and nervous system during the first 2 months following head injury to identify predictors of long-term consequences of TBI; and continue research to understand cell death and neuroprotection (protection of the brain) mechanisms and determine critical thresholds for secondary injuries (polytrauma) complicating TBI. <b>FY 2015 Plans:</b>		0.660	0.990
			1.500

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> S14 / Sci BS/Cbt Cas Care Rs	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
Will continue studies applying systems biology metrics to models of mild and severe TBI to aid in discovery of novel proteins in the blood that appear as a result of traumatic injury, which may aid in diagnosis of TBI. Will continue basic research to study the brain and nervous system during the sub-acute (weeks) and chronic (months) periods after head injury to identify predictors of long-term consequences of TBI. Will continue research to understand cell death and neuroprotection (protection of the brain) mechanisms and determine critical thresholds for secondary injuries (polytrauma) complicating TBI. Will conduct studies to determine the time course of neuroplasticity (capacity of the nervous system for adaptation or regeneration after trauma) markers during the post-injury recovery periods.			
<b>Title:</b> Clinical and Rehabilitative Medicine  <b>Description:</b> This effort conducts basic studies of mechanisms of tissue growth and traumatic injury to gain an understanding that will assist or facilitate the healing or transplantation process. The focus is placed on severe blast trauma to the limbs, head, face (including eye), and genitalia, abdomen and burns.  <b>FY 2013 Accomplishments:</b> Explored the mechanisms of eye trauma injury and the epidemiology (studying incidence or prevalence of injury) of eye trauma wounds and explored innovative strategies to regenerate tissues and advance promising approaches to the applied research phase.  <b>FY 2014 Plans:</b> Evaluate the cellular mechanisms of eye trauma injuries to identify promising therapies for eye trauma wounds and explore the epidemiology (studying incidence or prevalence of injury) (including severity) of eye trauma injuries and explore innovative strategies to regenerate tissues and advance promising approaches to the applied research phase to repair extremities (arms and legs), craniomaxillofacial (head, neck, face, and jaw), genital, and abdominal regions.  <b>FY 2015 Plans:</b> Will explore the cellular mechanisms and functional challenges of eye trauma injuries and advance promising therapies for eye trauma wounds into the applied research phase; correlate the epidemiology (incidence, prevalence and severity) of eye trauma with clinical outcomes; explore innovative strategies to regenerate and reconstruct tissues to enable promising approaches to advance into the applied research phase through directed experimentation in the lab and in animal models to address injury of the extremities (arms and legs), craniomaxillofacial (head, neck, face and jaw), genital, and abdominal regions.		5.443	4.920
<b>Accomplishments/Planned Programs Subtotals</b>		8.794	9.167
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A			4.750
			10.553

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES	Project (Number/Name) S14 / Sci BS/Cbt Cas Care Rs
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 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) S15 / Sci BS/Army Op Med Rsh			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
S15: Sci BS/Army Op Med Rsh	-	5.013	7.366	6.815	-	6.815	6.636	6.720	6.831	6.961	-	-

# The FY 2015 OCO Request will be submitted at a later date.

## A. Mission Description and Budget Item Justification

This project fosters basic research on physiological and psychological factors limiting Soldier effectiveness and on the characterization of health hazards generated by military systems and resulting as a consequence of military operations. This project includes research on the neurobehavioral aspects of post-traumatic stress and suicide and develops concepts for medical countermeasures to prevent or mitigate the effects of muscle and bone injury as well as to reduce the effects of sleep loss and other stressors on Warfighter performance. The hazards of exposure to directed energy, repetitive use, fatigue, heat, cold, and altitude are also investigated under this project.

Research conducted in this project focuses on the following four areas:

- (1) Injury Prevention and Reduction
- (2) Physiological Health
- (3) Environmental Health and Protection
- (4) Psychological Health and Resilience

Work in this project complements and is fully coordinated with PE 0602787A (Medical 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 Walter Reed Army Institute of Research (WRAIR), Silver Spring, MD; US Army Institute of Surgical Research (USAISR), San Antonio TX; and the U.S. Army Research Institute of Environmental Medicine (USARIEM), Natick, MA.

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

	<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>
<b>Title:</b> Injury Prevention and Reduction	1.174	1.185	1.000
<b>Description:</b> This effort identifies biological patterns of change in Soldiers during states of physical exertion, identifies physiological (human physical and biochemical functions) mechanisms of physical injury and exertion that will predict musculoskeletal (muscle, bone, tendons, and ligaments) injury, and establishes laser dose-response for eye tissue.			
<b>FY 2013 Accomplishments:</b>			



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Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES	Project (Number/Name) S15 / Sci BS/Army Op Med Rsh		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
Identified indicators of cellular responses to determine efficacy of intervention strategies related to injury susceptibility in the skeletal muscle; diagnosed and characterized repeated and long-duration exposure from military lasers; and characterized ocular injury as a function of shock wave (resulting from explosion of an improvised explosive device) impulse in a large-eye animal model to establish advanced triage, treatment, and prevention methodologies. These data will lead to our understanding of multiple ocular injuries from a single blast or laser exposure and will also anchor predictive biophysical models to prevent or mitigate Soldier eye injury from blast.  <b>FY 2014 Plans:</b> Explore musculoskeletal injury and repair mechanisms to identify possible therapeutic targets that regulate skeletal muscle and bone function; assess damage to the retina (a light-sensitive membrane in the back of the eye that receives an image from the lens and sends it to the brain through the optic nerve) of the eye following changes to long-duration exposures using advanced ophthalmic (eye) imaging systems and retinal scanning devices; and establish ocular (eye) injury metrics for blast exposures.  <b>FY 2015 Plans:</b> Will explore inflammatory processes in muscle and surrounding tissues following physical injury and during cellular repair using cell and animal models. Retinal imaging (photographic procedure that details the optic nerve, retinal blood vessels and the light sensing tissues in the back of the eye) will be used to examine and document the presence or absence of visible retinal alterations following blast exposure to rodents and laser exposures to eyes in a non-human primate model.				
<b>Title:</b> Physiological Health  <b>Description:</b> This effort conducts research on the physiological (human physical and biochemical functions) mechanisms of sleep, fatigue, and nutrition on Soldier performance and well-being.  <b>FY 2013 Accomplishments:</b> Determined muscle metabolic responses to nutritional deficit; identified the relationship between micronutrient and bone adaptation during military training; and identified the effects of energy deficits on human brain function and cognitive performance. These results will lead to an increased understanding of the benefits of adequate nutrition for the Warfighter.  <b>FY 2014 Plans:</b> Determine whether electrical brain stimulation can be used to induce sleep; explore promoting sleep during intervals between missions when sleep is not physiologically required; establish nutritional requirements for optimizing muscle formation and repair; determine the effects of various nutritional interventions on cell function; explore various nutritional interventions that might enhance resistance to cellular injury; and explore nutritional interventions that might promote physiological improvements to training and enhance recovery from physical injury.  <b>FY 2015 Plans:</b>		1.789	3.041	2.515

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> S15 / Sci BS/Army Op Med Rsh	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
Will investigate the metabolic mechanisms underlying injury recovery and explore the capability of macronutrients and micronutrients to promote metabolic recovery using cell and animal models. Will determine the neurophysiological (branch of physiology that studies how the nervous system functions on a molecular and tissue level) basis of recuperation during sleep and explore the use of pharmacological (drugs/pharmaceuticals) and non-pharmacological approaches for improving the recuperation processes during sleep.			
<b>Title:</b> Environmental Health and Protection  <b>Description:</b> This effort conducts research on the physiological (human physical and biochemical functions) mechanisms of exposure to extreme heat, cold, altitude, and other environmental stressors.  <b>FY 2013 Accomplishments:</b> Identified how clinical pathways alter progression and extent of organ damage following heat injury/stroke. These studies will determined the role of inflammation in multi-organ failure, and the results will be used to develop protective treatments against damage to internal organs resulting from heat exposure.  <b>FY 2014 Plans:</b> Identify metabolic pathways that are regulated by inflammation, which increases heat stroke susceptibility and/or alters the time course and extent of organ damage following heat injury that results in multi-organ failure, and explore treatments to protect against organ damage resulting from heat injuries.  <b>FY 2015 Plans:</b> Will use animal models to identify sensitive biomarkers of organ damage and delineate the molecular pathways of heat injury. This data can be used to identify targets for therapeutic interventions to accelerate recovery from heat injury.		0.453	0.804
<b>Title:</b> Psychological Health and Resilience  <b>Description:</b> This effort conducts research into the basic mechanisms of psychological resilience (i.e., mental toughness and the ability to overcome traumatic events) and post-concussion related mental and physical challenges and includes determination of suicide risk and understanding underlying mechanisms driving suicidal behavior, as well as underlying neurobiological mechanisms related to post-traumatic stress disorder (PTSD) and depression.  <b>FY 2013 Accomplishments:</b> Identified markers to indicate the effectiveness of candidate medications for PTSD treatments, and through exploration with an animal model, existing candidate compounds are evaluated for efficacy in the treatment of PTSD. Neural systems' response to depression treatment is used to inform development of optimized treatment regimen for depression.  <b>FY 2014 Plans:</b>		1.597	2.500

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
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<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p>Determine whether a sleep-related intervention strategy can enhance resilience to concussion/mild TBI effects in a proof-of-concept rodent model and evaluate the extent to which sleep is effective for enhancing resilience to concussion, which will potentially provide a preventative strategy to decrease negative consequences of concussions; establish cellular mechanisms for regulation of PTSD symptoms associated with increased stress sensitivity and increased anxiety in a rodent model of PTSD.</p> <p><b>FY 2015 Plans:</b> Will utilize an animal model for traumatic exposure, traumatic stress symptoms, and recovery to do a preliminary screening of pharmaceuticals that may impact mental health status. The results of these studies will create a methodology for sequential testing of novel pharmaceuticals that will lead ultimately to clinical trials for the treatment of PTSD. Will identify the association of exposure to blast and/or blunt impact on the likelihood of a brain concussion in a rodent model.</p>			
<b>Accomplishments/Planned Programs Subtotals</b>		5.013	7.366
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) T22 / Soil & Rock Mech			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
T22: Soil & Rock Mech	-	3.951	4.577	5.704	-	5.704	4.484	4.548	4.624	4.710	-	-

# The FY 2015 OCO Request will be submitted at a later date.

**A. Mission Description and Budget Item Justification**

This project fosters basic research to correlate the effects of the nano- and micro-scale behavior on the macro-scale performance of geological and structural materials to provide a foundation for the creation of future revolutionary materials and to revolutionize the understanding of sensor data within a heterogeneous geological systems. This research encompasses geologic and structural material behavior, structural systems, and the interaction with dynamic and static loadings. Research includes: underlying physics and chemistry that controls the mechanics and electromagnetic behavior of geological and structural materials, new techniques that provide measurements at the fundamental scale, and fundamental theories for relating nano- and micro-scale phenomena to macro-scale performance.

Work in this project provides the basis for applied research in PE 0602784A (Military Engineering Technology), Project T40 (Mobility/Weapons Effects Technology). 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 Engineer Research and Development Center (ERDC), Vicksburg, MS.

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

	<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>
<b>Title:</b> Military Engineering Basic Research	2.042	2.318	2.404
<b>Description:</b> Funding is provided for this activity			
<b>FY 2013 Accomplishments:</b> Developed basic wave propagation/sensor interaction knowledge, modifications to current and future data analysis, processing, and classification algorithms to account for use of conduit, and produced a modeling framework for future variable manipulation.			
<b>FY 2014 Plans:</b> Quantify the amplitude, frequency content, and time series of seismic loads caused by the impact of tools on granular media; determine the effect of snow grain shape on near-infrared reflectance; estimate soil texture and moisture from polarimetric imaging.			
<b>FY 2015 Plans:</b> Will develop improved understanding of interaction between gel chemistry and concrete to reduce explosive spalling under ultra-high temperatures; will investigate multi-temporal radar physics to identify frequency dependencies of roughness scale and grain			

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> T22 / Soil & Rock Mech	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
size of dielectrically similar soils and snow; will direct tunable bacteriophage morphology to assemble high-ordered nano-scale structures.			
<b>Title:</b> Materials Modeling for Force Protection  <b>Description:</b> The long-term goal of this task is to develop a structural ceramic composite that could replace steel and aluminum for most applications at one third the weight. To accomplish this goal, a technical ceramic such as silicon carbide will have to be improved five-fold in tensile strength and fracture toughness.  <b>FY 2013 Accomplishments:</b> Created experimental techniques that provide measurements at the nano- to micro-scale that allowed for validation and verification of simulations of material. These techniques generated a better understanding of how bio-lamina are created and how or if those processes can be exploited for synthesis and self-healing.  <b>FY 2014 Plans:</b> Model deformation and change in particles using a novel Mixed Least Squares method for Finite Elements that permits discontinuities in the displacement field of the particles; determine if polycrystalline ceramics can theoretically be improved by multiple-fold current values of fracture toughness and tensile strength; determine energy dissipation mechanisms in nano-coiled vertically aligned carbon nanotubes with a stiffness gradient under dynamic loading conditions.  <b>FY 2015 Plans:</b> Will identify and introduce energy dissipation mechanisms in novel multi-layered, heterogeneous structural systems to achieve significant weight reduction; will investigate fundamental nano-scale parameters of biological protective materials on the macro-scale damage variables of a multi-layered protective material, where the macro-scale variables will be incorporated into simulations of multi-layered nano-composite materials.		1.909	2.259
<b>Accomplishments/Planned Programs Subtotals</b>		3.951	4.577
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) T23 / Basic Res Mil Const			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
T23: Basic Res Mil Const	-	1.618	1.772	2.102	-	2.102	1.733	1.757	1.787	1.820	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
Note Not applicable for this item												
A. Mission Description and Budget Item Justification												
Work in the project fosters basic research and supports facilities research initiatives. The research is focused on forming an explicit and mathematically robust set of algorithms for geometrical reasoning; assessing the conceptual feasibility of applying nanoparticle technology to real-time sensors, thermal conductivity, and high strength materials; and developing novel and advanced concepts for mitigating the effect of chemical and biological agents in built structures. These efforts provide basic research leading to improved design in a range of facilities to optimize facility mission performance, enhance facility security, reduce design and construction errors and omissions, reduce resource requirements, and reduce the environmental burdens over the facility's life. This project provides leap-ahead technologies to solve military-unique problems in the planning, programming, design, construction, and sustainment of deployed facilities, and energy and utility infrastructure.												
Work in this project provides the basic research basis for applied research in PE 0602784A (Military Engineering Technology), Projects T41 (Military Facilities Engineering Technology) and T45 (Energy Technology Applied to Military Facilities).												
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 Engineer Research and Development Center (ERDC), Vicksburg, MS.												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2013	FY 2014	FY 2015	
Title: Facilities Research									1.618	1.772	2.102	
Description: Funding is provided for the following effort.												
FY 2013 Accomplishments: Completed investigations of enhanced heat transfer of hybrid surfaces and switching mechanisms in bioinspired polymers.												
FY 2014 Plans: Determine the relationship between amino acid sequence and nanostructure self-assembly properties in a unique protein motif; redirect electron flux from highly reduced organic fermentation products towards hydrogenase production.												
FY 2015 Plans:												

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> T23 / Basic Res Mil Const	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
Will determine fundamental processes in microbial interactions with surfaces that lead to bio-fouling and corrosion; will re-create plant photosynthesis processes in an artificial cell matrix.			
<b>Accomplishments/Planned Programs Subtotals</b>		1.618	1.772
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b> N/A			
<b>E. Performance Metrics</b> N/A			

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army										<b>Date:</b> March 2014		
<b>Appropriation/Budget Activity</b> 2040 / 1					<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES				<b>Project (Number/Name)</b> T24 / Signature Physics And Terrain State Basic Research			
<b>COST (\$ in Millions)</b>	<b>Prior Years</b>	<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015 Base</b>	<b>FY 2015 OCO #</b>	<b>FY 2015 Total</b>	<b>FY 2016</b>	<b>FY 2017</b>	<b>FY 2018</b>	<b>FY 2019</b>	<b>Cost To Complete</b>	<b>Total Cost</b>
T24: Signature Physics And Terrain State Basic Research	-	1.424	1.600	2.005	-	2.005	1.635	1.655	1.681	1.715	-	-
<p># The FY 2015 OCO Request will be submitted at a later date.</p> <p><b>Note</b> Not applicable for this item</p> <p><b>A. Mission Description and Budget Item Justification</b>  This project supports basic research to increase knowledge in the areas of terrain state and signature physics. It investigates the knowledge base for understanding and assessing environmental impacts critical to battlespace awareness. Projects include fundamental material characterization, investigation of physical and chemical processes, and examination of energy/mass transfer applicable to predicting state of the terrain, which control the effects of the environment on targets and target background signatures and mobility in support of the materiel development community. The terrain state area of terrestrial sciences investigates weather-driven terrain material changes and sensing/infering subsurface properties. The signature physics area of terrestrial sciences focuses on understanding the dynamic changes to electromagnetic, acoustic and seismic signatures, and energy propagation in response to changing terrain state and near surface atmosphere.</p> <p>Work in this project provides a foundation for applied research in PE 0602784A (Military Engineering Technology), Project 855 (Topographical, Image Intel and Space) and T42 (Terrestrial Science Applied Research).</p> <p>The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering science and technology focus areas and the Army Modernization Strategy.</p> <p>Work in this project is performed by the US Army Engineer Research and Development Center (ERDC), Vicksburg, MS.</p>												
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>									<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>	
<b>Title:</b> Analysis for Signal and Signature Phenomenology (Previously titled - Terrain State and Signature Physics)									1.424	1.600	2.005	
<b>Description:</b> Funding is provided for the following effort.												
<b>FY 2013 Accomplishments:</b> Formulated new statistical approaches for improved sensing and communication systems operating in complex terrestrial environments with new quantitative measures for heterogeneity and intermittency of random terrestrial media; formulated a												



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<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> T24 / Signature Physics And Terrain State Basic Research	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p>methodology for assessing motivational intensities (cognitive-based processes) contributing to movement patterns in constrained landscapes.</p> <p><b>FY 2014 Plans:</b> Investigate and quantify full waveform Light Detection and Ranging (LiDAR) backscatter characteristics and known system response to enhance sensor calibration models for increased target identification in variable terrain environments; research and define annually repeating spatial snow patterns as a function of topography, vegetation, and weather, and determine the efficacy and utility of this new knowledge to improve satellite derived snow mapping estimates of depth and density for enhancing water storage estimates and mobility products.</p> <p><b>FY 2015 Plans:</b> Will investigate radio frequency propagation signal loss in mountainous terrain shadow zones to determine causes of attenuation variance to model predictions and determine the utility of a low frequency simulation with reduced computational demand to emulate actual high frequency behavior; will enable realistic modeling of high bandwidth impulsive waveforms to improve space/time localization of high resolution acoustic and electromagnetic receivers by extending wave propagation theory in random media to include decorrelations of signals over separations in space and time resulting from dynamic variability of the atmosphere.</p>			
<b>Accomplishments/Planned Programs Subtotals</b>		1.424	1.600
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) T25 / Environmental Science Basic Research			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
T25: Environmental Science Basic Research	-	5.620	7.171	7.303	-	7.303	7.028	7.129	7.251	7.385	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
Note Not applicable for this item												
A. Mission Description and Budget Item Justification												
This project supports basic research to investigate fundamental scientific principles and phenomena necessary to ensure efficient development of the technologies needed to address Army sustainment issues in the restoration, compliance, conservation, and non-industrial pollution prevention areas. These efforts include: investigating and monitoring contaminated sites, including chemical contamination and unexploded ordnance (UXO) detection/discrimination; better characterization of contaminants through improved risk-based assessment; destruction, containment, or neutralization of organics in water, soil, and sediments resulting from military activities; adhering to applicable federal, state, and local environmental laws and regulations; monitoring and controlling noise generation and transport; protecting and enhancing natural and cultural resources; reducing pollution associated with military activities; and the study of ecosystem genomics and proteomics in support of the Army's new Network Science initiative.												
Work in this project provides a fundamental basis for applied research in PE 0602720A (Environmental Quality Technology), Project 048 (Industrial Operations Pollution Control Technology), Project 835 (Military Medical Environmental Criteria) and Project 896 (Base Facilities Environmental Quality).												
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 Engineer Research and Development Center (ERDC), Vicksburg, MS.												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2013	FY 2014	FY 2015	
Title: Environmental and Ecological Fate of Explosives, Energetics, and Other Contaminants									2.607	2.794	2.900	
Description: Funding is provided for the following effort.												
FY 2013 Accomplishments: Initiated research on amphibian response to various militarily relevant chemicals and materials to develop an understanding of if and how these unique organisms are impacted; developed an understanding of transport of compounds through cellular channels												

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Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES	Project (Number/Name) T25 / Environmental Science Basic Research		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
that will allow information for more sensitive nano-sensors; investigated the new insensitive munitions behavior and persistence in environmental condition and media.  <b>FY 2014 Plans:</b> Understand the fundamental physics that control transport of both ionic and neutral species through nanochannels; rapidly characterize structural changes in integral membrane proteins upon ligand binding; determine soil mobility and bioavailability of IMX-101 in terrestrial systems; expand the metabolic capacity of aerobic RDX- degrading bacteria to enable degradation of 4-nitro-2,4-diazabutanal.  <b>FY 2015 Plans:</b> Will determine the fundamental biological mechanisms that predict interactions of new insensitive munitions with environmental constituents; will increase understanding of chemical-environmental interactions and ecosystem functions for advanced sensing; will provide underlying mechanisms of biological networks to utilize in man-made systems.				
<b>Title:</b> Fundamental Understanding of Explosives, Energetics and UXO in the Environment  <b>Description:</b> Previously titled:Remediation of Explosives, Energetics, and UXO  <b>FY 2013 Accomplishments:</b> Investigated the mineralization of depleted uranium munitions and effects on solubility, sorption, and mobility; explored novel microbial systems for degrading energetic compounds; and studied the bioavailability implications of interactions between munitions constituents and performance enhancing nano-material in mixtures.  <b>FY 2014 Plans:</b> Determine the potential for bioaccumulation and food-chain transfer of 2,4 Dinitroanisole; isolate and chemically identify predominant phytosiderophores and/or organic acids exuded by two grass plants that may serve to complex lead; identify and characterize novel biocatalysts involved in the direct incorporation of molecular oxygen into amines resulting in a green biosynthesis route to energetic.  <b>FY 2015 Plans:</b> Will determine the potential for use of aquatic biological systems as a basis for trace chemical sensors in water; will determine how understanding of chemical impact on biological systems can be translated across different species through similarities in molecular systems; will identify the mode of toxic interactions of multiple chemical mixtures in the IMX.		1.567	2.296	2.396
<b>Title:</b> Training Land Natural Resources  <b>Description:</b> Funding is provided for the following effort.  <b>FY 2013 Accomplishments:</b>		0.491	1.007	1.107

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Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES	Project (Number/Name) T25 / Environmental Science Basic Research		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
Investigated how climate induced change affects the adsorption and biotransformation characteristics of northern peat-land ecosystems; conducted mechanistic investigations of Lead (Pb) chemical separation by plant exudates to advance understanding on the potential for plant exudates to mobilize Pb in the presence of environmentally relevant completing interactions; analyzed pollination networks and nectar-dwelling yeast communities and discerned shared dynamics and structural interactions between two systems to continue to advance the fundamental knowledge for management of rate and endemic plant and pollinator species on Army ranges.  <b>FY 2014 Plans:</b> Devise a mathematical description of multiple scattering of impulsive signals that includes variability due to spatial and size distributions of scattering objects; determine how climate induced change affects the adsorption and biotransformation characteristics of peatland ecosystems; characterize and compare munitions compounds and insensitive munitions impacts on critically sensitive larval stages of amphibian development.  <b>FY 2015 Plans:</b> Will study how invasive species impact the affected ecosystem at the molecular level; will investigate potential of novel mechanisms to assess ecosystem components utilizing specialized monitoring of unique sounds.				
<b>Title:</b> Network Science  <b>Description:</b> Funding is provided for the following effort.  <b>FY 2013 Accomplishments:</b> Investigated the molecular architecture that dictates the highly specific ligand preference of insect pheromone receptors based on amino acid networks for intelligent receptor design; investigated genetic and genomic basis of intra-species variance in sensitivity to munitions and reduced uncertainty in risk/toxicity assessment of military sites; explored the trade-offs between adaptability and susceptibility within self-organizing biological networks.  <b>FY 2014 Plans:</b> Investigate genetic and genomic basis for differences in chemical sensitivity between different asexually or sexually reproducing populations; characterize sensitivity to traditional (lead) and insensitive (dinitroanisole) munitions over time under ideal and stressful conditions; quantify the long-term contribution of environmental stress to sensitivity drifting in age stratified, reproducing populations.  <b>FY 2015 Plans:</b> Will investigate how molecular design impacts biological function and how this can be translated to man-made systems like robotics; will investigate biological cell assembly mechanisms for man-made systems and programming.		0.955	1.074	0.900
Accomplishments/Planned Programs Subtotals		5.620	7.171	7.303

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> T25 / Environmental Science Basic Research
<b><u>C. Other Program Funding Summary (\$ in Millions)</u></b> N/A <b><u>Remarks</u></b>  <b><u>D. Acquisition Strategy</u></b> N/A  <b><u>E. Performance Metrics</u></b> N/A		

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) T63 / Robotics Autonomy, Manipulation, & Portability Rsh			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
T63: Robotics Autonomy, Manipulation, & Portability Rsh	-	1.760	1.990	7.000	-	7.000	7.286	7.218	7.443	8.140	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
Note Not applicable for this item.												
A. Mission Description and Budget Item Justification												
<p>This project supports basic research in areas that expands the autonomous capabilities, utility, and portability of small robotic systems for military applications, with a focus on enhanced intelligence, biomimetic functionality, and robust mobility, to permit these systems to serve as productive tools for dismounted Soldiers. It enables future systems to support and unburden Soldiers by integrating technologies with an understanding of cognitive and physical needs, and the missions of the humans and (non-human) agents operating on the battlefield. The ability of the Warfighter to command a suite of small unmanned systems (e.g., air, ground, and hybrid vehicles) reduces exposure of the Soldier to harm and improves the efficiency by which a dismounted unit achieves tactical objectives such as securing a targeted zone. Example missions requiring enhanced autonomy, manipulation, and man-portability include rapid room clearing and interior structure mapping; detection of human presence, chemical/biological/nuclear/radiological/explosive (CBNRE), and booby-traps; surveillance; and subterranean passage detection and exploration. Because of their relatively small size, light weight, and service in dismounted environments, small unmanned systems have unique challenges in perception, autonomous processing, mobility mechanics, propulsive power, and multi-functional packaging that transcend similar challenges associated with large unmanned systems. The U.S. Army Research Lab conducts research in related disciplines, including machine perception, intelligent control, biomimetic robotics, manipulator mechanics, and propulsive power and drives to foster the development of technologies for lightweight, small-volume, environmentally-harsh robotics applications. Machine perception research includes the exploration of lightweight ultra-compact sensor phenomenology and the maturation of basic machine vision algorithms that enable small unmanned systems to more fully understand their local environment. Intelligent control research includes the maturation of autonomous processing capabilities and the advancement of artificial intelligence techniques that lead to reliable autonomous behavior in a large-displacement, highly-dynamic environment and permit unmonitored task performance. Research in biomimetic robotics and manipulator mechanics includes the advancement of mechatronic and biomimetic appendages to enable agile high-speed locomotion, dexterous task-performance, and environmental-manipulation; and the maturing of nonlinear control algorithms to support robust, stable mobility. Propulsion power and drives research includes investigations of engine cycles and alternative hybrid energy conversion techniques to provide compact, lightweight, quiet, low-emission, high-density power sources that support highly-portable unmanned systems capable of performing long-endurance missions.</p>												
<p>Work in this project supports key Army needs and provides the technical underpinnings to several Program Elements (PEs) to include PE 0601104A (University and Industry Research Center)/H54 (Micro-Autonomous Systems Technology Collaborative Technology Alliance) and PE 0602622A (Chemical, Smoke and equipment Defeating Technology)/544 (Smoke/Novel Effect Munition).</p>												
<p>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.</p>												

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014		
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES	Project (Number/Name) T63 / Robotics Autonomy, Manipulation, & Portability Rsh		
Work in this project is performed by the U.S. Army Research Laboratory (ARL) at the Aberdeen Proving Ground, MD.				
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
Title: Robotics Autonomy and Human Robotic Interface Research		1.760	1.990	2.000
Description: In-house research with a focus on enabling robust autonomous mobility for small robotic systems, including autonomous operations in Global Positioning System (GPS) denied areas, planning, behaviors, intelligent control, and the interface of perception technologies to accomplish Army missions in the area of unmanned systems. These efforts will include research activities in micromechanics conducted in association with the Micro Autonomous Systems and Technology Collaborative Technology Alliance.				
FY 2013 Accomplishments: Conducted experimental studies to create a fundamental model of flapping wing locomotion to enable future micro-scale unmanned aerial vehicle systems; examined the basic concepts and underpinning mechanics of grasping and manipulating unknown, arbitrarily shaped objects.				
FY 2014 Plans: Conduct experimental studies to investigate the fundamental flow behavior of small scale flyers as it impacts range and endurance; investigate cognitive approaches for machine perception; explore concepts from game theory and machine learning to determine adversarial intent from sensor observations; examine mechanics and control related to whole body manipulation; and examine novel locomotion mechanisms focusing upon energy efficiency and mobility.				
FY 2015 Plans: Will conduct experimental studies related to fundamental flow behavior of very small scale air vehicles; explore algorithms for semantic labeling and relationship determination between objects in the environment to permit robots to interact with soldiers using more intuitive and natural means and to enable the robot to infer the purpose of objects and human activity; and examine novel locomotion concepts to enable greater efficiency and application in complex and confined environments.				
Title: Intelligent Systems		-	-	5.000
Description: Pursue in-house research that supports and unburdens Soldiers in a flexible, robust, survivable and comprehensive manner. This work will address the cognitive requirements of humans and (non-human) agents, both hardware and software based, operating individually or in collaboration, on the battlefield. Emphasis will be placed on perception, reasoning, and collaboration techniques that can apply to and transfer between a broad range of systems (such as: adaptive communication and data collection networks; cyber defense, crowd-sourcing and information retrieval software agents; and predictive and explanatory decision support systems).				
FY 2015 Plans:				

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> T63 / Robotics Autonomy, Manipulation, & Portability Rsh	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
Will explore, and characterize architectures and algorithms for intelligent explanation, facilitating human interpretation of machine outputs; investigate techniques for limited supervised learning to enhance machine recognition of threats and objectives and assess their impact on baseline planning algorithms; and address socially-inspired concepts for collective intelligence in the context of dynamic situation assessment, re-organization and collaboration.			
<b>Accomplishments/Planned Programs Subtotals</b>		1.760	1.990
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			



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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) T64 / Sci BS/System Biology And Network Science			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
T64: Sci BS/System Biology And Network Science	-	2.726	2.958	2.398	-	2.398	2.952	2.996	3.048	3.102	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
A. Mission Description and Budget Item Justification												
This project fosters research investigations through a modernized systematic approach that uses iterative computer simulation with mathematical modeling and biological information to analyze and refine biological studies. The information gained from these studies have potential to provide a better understanding of the overall biological system and its molecular network of interactions, which leads to improved early strategic decision-making in the development of preventive and treatment solutions to diseases. This approach establishes a model for application of computational biology processes and knowledge of biological networks to discover medical products that prevent and/or treat diseases or medical conditions.												
The cited work provides theoretical underpinnings for PE 0602787A (Medical Technology).												
Work in this project is performed by USAMRMC, Fort Detrick, MD.												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2013	FY 2014	FY 2015	
Title: Network Sciences Initiative									2.726	2.958	2.398	
Description: This effort supports research using iterative computer simulation with mathematical modeling and biological information to analyze and refine biological studies.												
FY 2013 Accomplishments: Expanded the identification of TBI biomarkers to include key biological pathways, leading to the development of diagnostic assays and identification of potential drug targets.												
FY 2014 Plans: Validate and extend algorithm for discovery of biomarkers (key molecular or cellular events that link a specific environmental exposure to a health outcome) for severe TBI to include moderate and mild TBI; develop systems biology algorithms to establish new strategies to identify drug targets and therapeutics for malaria- and trauma-induced coagulopathy (abnormal blood clotting); exploit novel in-silico (performed on computer via simulation) models to identify sensitive biomarkers and determine the time course of wound healing; and develop mathematical models to characterize how viruses escape immune response to support the development of anti-viral drugs.												
FY 2015 Plans:												

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014	
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES	Project (Number/Name) T64 / Sci BS/System Biology And Network Science	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
Will use algorithms to investigate the discrimination between biomarkers (key molecular or cellular events, such as the presence of specific proteins, that link a specific environmental exposure to a health outcome) of mild, moderate, and severe TBI; will test and extend computational biology algorithms to identify drug targets and therapeutics for conditions such as infectious disease (e.g., malaria); will develop mathematical models of upper respiratory airflow patterns for the non-invasive diagnosis of pulmonary (lung) diseases; will computationally predict potential drug targets that could induce re-sensitization to current antibiotics in biofilm-producing bacteria (bacteria that can form into a thin layer that adheres to surfaces including tissues of the body, bacterial biofilms are more antibiotic-resistant); will mathematically model standard vital-sign data to enable the non-invasive prediction of heat stress injury and allow for timely counteractive measures.			
<b>Accomplishments/Planned Programs Subtotals</b>		2.726	2.398
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			

# UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601102A / DEFENSE RESEARCH SCIENCES				Project (Number/Name) VR9 / Surface Science Research			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
VR9: Surface Science Research	-	1.717	2.009	2.500	-	2.500	2.239	2.273	2.312	2.354	-	-

# The FY 2015 OCO Request will be submitted at a later date.

## Note

Not applicable for this item.

## A. Mission Description and Budget Item Justification

This project fosters basic research to establish and maintain a core capability to enable a molecular level understanding of properties and behaviors of materials relevant to the Army; by developing understanding and ability to manipulate nanostructured materials as a means to tune properties which meet desired performance requirements; by advancing the scientific understanding of surface properties and interfacial dynamics of complex materials; and by providing scalable processes grounded in a molecular understanding of materials. This project funds basic research in the characterization of chemical and biochemical phenomena occurring at or near solid surfaces and interfaces; the interactions between chemical reactions and transport processes on surfaces; theory and modeling of processes at complex surfaces; and the synthesis and characterization of catalysts that function at the nanoscale. Investment in basic research centered on the surface science disciplines will enable growth of a knowledge base that will result in improved understanding of the interactions of complex materials in real world environments.

The cited work provides the theoretical underpinnings for PE 0602622A (Chemical, Smoke and Equipment Defeating Technology).

Work in this project is performed by the Edgewood Chemical and Biological Center (ECBC), Research, Development and Engineering Command, in Aberdeen, Maryland.

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

	<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>
<b>Title:</b> Surface Science Research	1.717	2.009	2.500
<b>Description:</b> The activities in this program are related to performing basic research in chemistry, biology and physics on fundamental problems related to surfaces, interfacial dynamics, thin film materials, chemical-biological catalysis and opto-electronic/sensory technologies.			
<b>FY 2013 Accomplishments:</b> Developed a robust set of surface science tools, both experimentally and theoretically, that can be used to further our understanding of surface properties and interfacial dynamics of complex materials; investigate rational design approaches to metal-metal oxide nano-architectures; systematically model engineered functional systems; investigated the mechanisms			

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601102A / DEFENSE RESEARCH SCIENCES	<b>Project (Number/Name)</b> VR9 / Surface Science Research	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
governing specific binding or adherence of biological molecules to abiotic surfaces; and performed structural determination and in silico modeling of trans-membrane proteins from human induced pluripotent cells			
<b>FY 2014 Plans:</b> Perform structural determination and computational modeling of trans-membrane proteins; building on FY13 efforts, continue to develop a set of surface science tools that further our understanding of surface properties and interfacial dynamics of complex materials; continue to investigate rational design approaches to metal-metal oxide nano-architectures; continue to systematically model engineered functional systems; investigate the mechanisms governing specific binding or adherence of biological molecules to abiotic surfaces.			
<b>FY 2015 Plans:</b> Will investigate chemical and biochemical phenomena occurring at or near solid surfaces and material interfaces, to include the effects of binding energy, reactions, transport and deposition; the interactions between chemical reactions and transport processes on surfaces; theory and modeling of processes at complex surfaces; and experimental work focused on the systematic understanding of surface structure, morphology (the study of form and structure), and surface group properties.			
<b>Accomplishments/Planned Programs Subtotals</b>		1.717	2.009
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			

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**Exhibit R-2, RDT&E Budget Item Justification:** PB 2015 Army **Date:** March 2014

<b>Appropriation/Budget Activity</b> 2040: <i>Research, Development, Test &amp; Evaluation, Army / BA 1: Basic Research</i>	<b>R-1 Program Element (Number/Name)</b> PE 0601103A / <i>University Research Initiatives</i>
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<b>COST (\$ in Millions)</b>	<b>Prior Years</b>	<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015 Base</b>	<b>FY 2015 OCO #</b>	<b>FY 2015 Total</b>	<b>FY 2016</b>	<b>FY 2017</b>	<b>FY 2018</b>	<b>FY 2019</b>	<b>Cost To Complete</b>	<b>Total Cost</b>
Total Program Element	-	72.243	79.317	69.808	-	69.808	73.136	73.288	74.511	76.550	-	-
D55: <i>University Research Initiative</i>	-	69.268	75.981	67.289	-	67.289	70.083	70.189	71.358	73.340	-	-
V72: <i>Minerva</i>	-	2.975	3.336	2.519	-	2.519	3.053	3.099	3.153	3.210	-	-

# The FY 2015 OCO Request will be submitted at a later date.

## **Note**

Funding reduced to support higher Army priorities.

## **A. Mission Description and Budget Item Justification**

This program element (PE) supports Army basic research efforts in the Multidisciplinary University Research Initiative (MURI) program, the Defense University Research Instrumentation Program (DURIP) and the Presidential Early Career Awards for Scientists and Engineers (PECASE) program by funding basic research in a wide range of scientific and engineering disciplines pertinent to maintaining the U.S. land combat technology superiority. Army MURI program efforts involve teams of researchers investigating high-priority, transformational topics that intersect more than one traditional technical discipline (e.g., Intelligent Luminescence for Communication, Display, and Identification). For many complex problems, this multidisciplinary approach serves to accelerate research progress and expedite transition of results to application. The DURIP provides funds to acquire major research equipment to augment current, or devise new, research capabilities in support of Army transformational research. The PECASE program funds single-investigator research efforts performed by outstanding academic scientists and engineers early in their independent research careers.

Project V72 supports Minerva Research Initiative (MRI), a university based social science research project initiated by the Secretary of Defense in FY09.

Work in the PE provides a foundation for applied research initiatives at the Army laboratories and research, development and engineering centers.

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 the Army Research Laboratory (ARL), Research Triangle Park, NC.

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Exhibit R-2, RDT&E Budget Item Justification: PB 2015 Army				Date: March 2014	
Appropriation/Budget Activity		R-1 Program Element (Number/Name)			
2040: Research, Development, Test & Evaluation, Army / BA 1: Basic Research		PE 0601103A / University Research Initiatives			
B. Program Change Summary (\$ in Millions)	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO	FY 2015 Total
Previous President's Budget	80.986	79.359	79.679	-	79.679
Current President's Budget	72.243	79.317	69.808	-	69.808
Total Adjustments	-8.743	-0.042	-9.871	-	-9.871
• Congressional General Reductions	-0.107	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-2.256	-			
• Adjustments to Budget Years	-	-	-9.871	-	-9.871
• Other Adjustments 1	-6.380	-	-	-	-
• Other Adjustments 2	-	-0.042	-	-	-

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601103A / University Research Initiatives				Project (Number/Name) D55 / University Research Initiative			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
D55: University Research Initiative	-	69.268	75.981	67.289	-	67.289	70.083	70.189	71.358	73.340	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
Note Not applicable for this item.												
A. Mission Description and Budget Item Justification												
This project supports the Multidisciplinary University Research Initiative (MURI), the Defense University Research Instrumentation Program (DURIP) and the Presidential Early Career Awards for Scientists and Engineers (PECASE) program. The MURI program funds university based basic research in a wide range of scientific and engineering disciplines pertinent to maintaining US land combat technology superiority. Army MURI efforts involve teams of researchers investigating high-priority, transformational topics that intersect more than one traditional technical discipline (e.g. Intelligent Luminescence for Communication, Display, and Identification). For many complex problems, this multidisciplinary approach serves to accelerate research progress and expedite transition of results to application. The DURIP provides funds to acquire major research equipment to augment current, or devise new, research capabilities in support of Army transformational research. The PECASE program funds single-investigator research efforts performed by outstanding academic scientists and engineers early in their independent research careers.												
Work in this project provides a foundation for applied research initiatives at the Army laboratories and research, development and engineering centers.												
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) located in Research Triangle Park, NC.												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2013	FY 2014	FY 2015	
Title: Multidisciplinary University Research Initiative (MURI)									57.529	57.525	50.600	
Description: MURI programs are typically 5 years in length at a cost of \$1.25M/yr.												
FY 2013 Accomplishments: Supported MURI awards made in prior years and initiated ten FY13 start MURI awards critical to supporting future force capabilities. Effective transition mechanisms included collaboration among principal investigators, participation by 6.2/6.3 program managers in MURI program reviews, and communication of the MURI research results to the U.S. ARL, the U.S. Army												

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014		
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601103A / University Research Initiatives	Project (Number/Name) D55 / University Research Initiative		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
Research, Development, and the Engineering Centers (RDECs), the U.S. Army Engineer Research and Development Center (ERDC), the U.S. Army Medical Research and Materiel Command (MRMC), U.S. Army Research Institute (ARI), and industry. <b>FY 2014 Plans:</b> Support MURI awards made in prior years and initiate 8 FY14 start MURI awards critical to supporting the future force. Effective transition mechanisms include collaboration among principal investigators, participation by 6.2/6.3 program managers in MURI program reviews, and communication of the MURI research results to the U.S. ARL, the U.S. Army RDECs, the U.S. Army ERDC, the U.S. Army MRMC, the U.S. ARI and industry. <b>FY 2015 Plans:</b> Will provide support for MURI awards made in prior years and will start six to eight new FY15 MURI awards critical to supporting the future force. Effective transition mechanisms include collaboration among principal investigators, participation by 6.2/6.3 program managers in MURI program reviews, and communication of the MURI research results to the U.S. ARL, the U.S. Army RDECs, the U.S. Army ERDC, the U.S. Army MRMC, the U.S. ARI and industry.				
<b>Title:</b> Presidential Early Career Awards for Scientists and Engineers (PECASE) <b>Description:</b> Supports PECASE investigators started in prior years.  <b>FY 2013 Accomplishments:</b> Continued support for prior year awardees and selected four new awards.  <b>FY 2014 Plans:</b> Select four new awardees and support prior year's awardees.  <b>FY 2015 Plans:</b> Will continue support for prior year awardees and select four new awards.		4.415	4.600	4.500
<b>Title:</b> Defense University Research Instrumentation Program (DURIP) <b>Description:</b> Supports basic research through competitive grants for research instrumentation.  <b>FY 2013 Accomplishments:</b> Awarded 54 competitive grants for research instrumentation to enhance universities' capabilities to conduct world class research critical to Army transformation.  <b>FY 2014 Plans:</b>		7.324	13.856	12.189



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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601103A / <i>University Research Initiatives</i>	<b>Project (Number/Name)</b> D55 / <i>University Research Initiative</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
Award competitive grants for research instrumentation to enhance universities' capabilities to conduct world class research critical to Army transformation.			
<b>FY 2015 Plans:</b> Will award competitive grants for research instrumentation to enhance universities' capabilities to conduct world class research critical to Army transformation.			
<b>Accomplishments/Planned Programs Subtotals</b>		69.268	75.981
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b> N/A			
<b>E. Performance Metrics</b> N/A			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601103A / University Research Initiatives				Project (Number/Name) V72 / Minerva			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
V72: Minerva	-	2.975	3.336	2.519	-	2.519	3.053	3.099	3.153	3.210	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
<b>Note</b> Not applicable for this item.												
<b>A. Mission Description and Budget Item Justification</b> This project supports the Minerva Research Initiative (MRI), a university-based social science research program initiated by the Secretary of Defense in FY09. It focuses on areas in the social sciences that are of strategic importance to U.S. national security policy which have not been substantially pursued in the past. The Minerva research effort will be performed to understand the internal military-political dynamics of repressive regimes, the vulnerabilities of regimes and institutions to various kinds of disruption and instability, the nature of crowd dynamics, group violence, community belief structures, the potential to influence public opinion and attitudes in diverse cultures, cultural effects on network security and military operations, the influence of technology on military capabilities of potential adversaries and allies, and other intersections of social-cultural issues with military activities and national security. Predictive models and other analysis tools will be developed. Leveraging the expertise in the social sciences within the academic community is needed to provide understanding of the roots of terrorist organizations and the challenges and opportunities for military operations in a culturally diverse environment. Better understanding at a fundamental level and new computational tools will provide a beneficial impact on war fighting capabilities at the national policy, military strategy, operational, and tactical levels, and will enhance the capabilities of intelligence activities at all levels. All research results are open source.  The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering science and technology priority focus areas and the Army Modernization Strategy.												
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>									FY 2013	FY 2014	FY 2015	
<b>Title:</b> The Minerva Research Initiative (MRI)									2.975	3.336	2.519	
<b>Description:</b> The MRI is a university-based social science research program initiated by the Secretary of Defense. It focuses on areas in the social sciences of strategic importance to U.S. national security policy. It seeks to increase the Department's intellectual capital in the social sciences and improve its ability to address future challenges and build bridges between the Department and the social science community. Minerva will bring together universities, research institutions, and individual scholars and support multidisciplinary and cross-institutional projects addressing specific topic areas determined by the Department.												
<b>FY 2013 Accomplishments:</b>												

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601103A / <i>University Research Initiatives</i>	<b>Project (Number/Name)</b> V72 / <i>Minerva</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p>Continued efforts on existing projects focused on social science and cultural issues affecting the U.S. military warfighting capabilities; continued providing support to OSD in managing the program in social science studies related to strategy and policy via research chairs and fellowships at Service schools and universities; validated predictive models developed in previous research with extensive field research and extended by new theoretical development; extended and strengthened collaborations with combatant commands, DoD policy staff, and governmental activities; and increased the number of workshops and training courses for high level policy staff.</p> <p><b>FY 2014 Plans:</b> Complete the university consortium projects started in FY09; support new and ongoing Minerva social science research of strategic importance to the Army and U.S. national security policy; focus research efforts on understanding group belief formation, factors causing or influencing social change and violence, societal resilience, theories of deterrence, and new approaches to conflict and cooperation.</p> <p><b>FY 2015 Plans:</b> Will test theories on the direct and indirect effects of characteristics of natural resources on violence and state stability, which may ultimately provide predictive models of the relationship between natural resources and conflict, and provide options for anticipating and mitigating the acceleration of violence around the globe; and perform social scientific surveys with neuroscientific brain imaging to reveal the role of moral values in social mobilization which in the long term may provide effective strategies and policies in reducing organized violence and preventing its contagion.</p>			
<b>Accomplishments/Planned Programs Subtotals</b>		2.975	3.336
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			

**UNCLASSIFIED**

Exhibit R-2, RDT&E Budget Item Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040: Research, Development, Test & Evaluation, Army / BA 1: Basic Research					R-1 Program Element (Number/Name) PE 0601104A / University and Industry Research Centers							
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
Total Program Element	-	95.867	113.601	102.737	-	102.737	101.024	102.535	104.302	109.696	-	-
EA6: Cyber Collaborative Research Alliance	-	-	3.008	4.200	-	4.200	3.257	3.306	3.363	4.923	-	-
F17: Neuroergonomics Collaborative Technology Alliance	-	4.680	5.378	3.991	-	3.991	5.293	5.372	5.465	5.562	-	-
H04: HBCU/MI Programs	-	2.494	2.959	2.105	-	2.105	1.901	1.944	1.995	2.049	-	-
H05: Institute For Collaborative Biotechnologies	-	10.834	12.451	8.000	-	8.000	6.532	6.645	6.777	6.921	-	-
H09: Robotics CTA	-	4.955	6.646	5.844	-	5.844	5.598	5.682	5.780	5.884	-	-
H50: Network Sciences Cta	-	11.573	14.193	11.500	-	11.500	11.196	11.364	11.560	11.771	-	-
H53: Army High Performance Computing Research Center	-	4.054	4.899	5.392	-	5.392	5.700	5.785	5.885	5.993	-	-
H54: Micro-Autonomous Systems Technology (MAST) CTA	-	7.078	8.092	7.303	-	7.303	7.735	7.851	7.987	8.131	-	-
H59: International Tech Centers	-	6.615	7.605	6.097	-	6.097	7.027	7.129	7.251	7.384	-	-
H64: MATERIALS CENTER	-	0.738	-	-	-	-	-	-	-	-	-	-
H73: Automotive Research Center (ARC)	-	3.649	4.193	3.157	-	3.157	3.156	3.203	3.258	3.318	-	-
J08: Institute For Creative Technologies (ICT)	-	7.134	8.099	7.500	-	7.500	6.125	6.232	6.356	6.490	-	-
J12: Institute For Soldier Nanotechnology (ISN)	-	9.287	10.553	6.713	-	6.713	6.125	6.232	6.356	6.492	-	-
J14: Army Educational Outreach Program	-	8.691	9.733	9.550	-	9.550	9.466	9.608	9.773	9.949	-	-
J15: Network Sciences ITA	-	3.912	4.122	3.861	-	3.861	4.275	4.339	4.414	4.493	-	-

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**Exhibit R-2, RDT&E Budget Item Justification: PB 2015 Army** **Date:** March 2014

Appropriation/Budget Activity					R-1 Program Element (Number/Name)							
2040: Research, Development, Test & Evaluation, Army / BA 1: Basic Research					PE 0601104A / University and Industry Research Centers							
J17: Vertical Lift Research Center Of Excellence	-	2.473	3.061	2.885	-	2.885	3.053	3.099	3.153	3.210	-	-
VS2: Multi-Scale Materials Modeling Centers	-	7.700	8.609	9.639	-	9.639	9.364	9.504	9.668	9.842	-	-
VS3: Center For Quantum Science Research	-	-	-	5.000	-	5.000	5.221	5.240	5.261	7.284	-	-

# The FY 2015 OCO Request will be submitted at a later date.

## Note

FY 13 funding was reduced due to Congressionally directed reprogramming of \$15.549 million for Historically Black Colleges and Universities and Minority Institutions (HBCU/MI) to RDT&E, Defense-wide appropriation, \$8.465 million for sequestration reductions, and \$2.971 million for SBIR/STTR transfers  
FY15 funding reduced to support higher Army priorities.

## A. Mission Description and Budget Item Justification

This program element (PE) fosters university and industry based research to provide a scientific foundation for enabling technologies for future force capabilities. Broadly, the work in this project falls into three categories: Collaborative Technology Alliances / Collaborative Research Alliances (CTAs/CRAs), University Centers of Excellence (COE), and University Affiliated Research Centers (UARCs). The Army formed CTAs to leverage large investments by the commercial sector in basic research areas that are of great interest to the Army. CTAs are industry-led partnerships between industry, academia, and the Army Research Laboratory (ARL) to incorporate the practicality of industry, the expansion of the boundaries of knowledge from universities, and Army scientists to shape, mature, and transition technology relevant to the Army mission. CTAs have been competitively established in the areas of Micro Autonomous Systems Technology (MAST), Network Sciences, Robotics, Cognition and Neuroergonomics, and Multi-Scale Materials Modeling. COEs focus on expanding the frontiers of knowledge in research areas where the Army has enduring needs, and couples state-of-the-art research programs at academic institutions with broad-based graduate education programs to increase the supply of scientists and engineers in automotive and rotary wing technology. Also included are Army Educational Outreach Program (AEOP) and activities to stimulate interest in science, math, and technology among middle and high school students. This PE includes support for basic research at three Army UARCs, which have been created to exploit opportunities to advance new capabilities through a sustained long-term multidisciplinary effort. The Institute for Soldier Nanotechnologies focuses on Soldier protection by emphasizing revolutionary materials research for advanced Soldier protection and survivability. The Institute for Collaborative Biotechnologies focuses on enabling network centric-technologies, and broadening the Army's use of biotechnology for the development of bio-inspired materials, sensors, and information processing. The Institute for Creative Technologies is a partnership with academia and the entertainment and gaming industries to leverage innovative research and concepts for training and simulation. Examples of specific research of mutual interest to the entertainment industry and the Army are technologies for realistic immersion in synthetic environments, networked simulation, standards for interoperability, and tools for creating simulated environments. This PE also includes the Historically Black Colleges and Universities and Minority Institution (HBCU/MI) Centers of Excellence that address critical research areas for Army Transformation.

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

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<b>Exhibit R-2, RDT&amp;E Budget Item Justification:</b> PB 2015 Army	<b>Date:</b> March 2014
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<b>Appropriation/Budget Activity</b> 2040: <i>Research, Development, Test &amp; Evaluation, Army I BA 1: Basic Research</i>	<b>R-1 Program Element (Number/Name)</b> PE 0601104A / <i>University and Industry Research Centers</i>
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Work in this PE is performed by the U. S. Army Research Lab (ARL) in Adelphi, MD; the U.S. Army Tank Automotive Research, Development, and Engineering Center (TARDEC) in Warren, MI; U.S. Army Aviation and Missile Research, Development and Engineering Center (AMRDEC), in Huntsville, AL, and U.S. Army Research, Development and Engineering Command (RDECOM), in Aberdeen, MD.

<b>B. Program Change Summary (\$ in Millions)</b>	<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015 Base</b>	<b>FY 2015 OCO</b>	<b>FY 2015 Total</b>
Previous President's Budget	123.045	113.662	118.502	-	118.502
Current President's Budget	95.867	113.601	102.737	-	102.737
Total Adjustments	-27.178	-0.061	-15.765	-	-15.765
• Congressional General Reductions	-0.183	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-15.559	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-2.971	-			
• Adjustments to Budget Years	-	-	-15.765	-	-15.765
• Other Adjustments 1	-8.465	-	-	-	-
• Other Adjustments 2	-	-0.061	-	-	-

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601104A / University and Industry Research Centers				Project (Number/Name) EA6 / Cyber Collaborative Research Alliance			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
EA6: Cyber Collaborative Research Alliance	-	-	3.008	4.200	-	4.200	3.257	3.306	3.363	4.923	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
A. Mission Description and Budget Item Justification												
The Cyber Security Collaborative Research Alliance (CRA), a competitively selected consortium, is formed to advance the theoretical foundations of cyber science in the context of Army networks. This CRA consists of academia, industry and government researchers working jointly with the objective of developing a fundamental understanding of cyber phenomena so that fundamental laws, theories, and theoretically grounded and empirically validated models can be applied to a broad range of Army domains, applications, and environments. This research will focus on three interrelated aspects of cyber security and will be conducted using a trans-disciplinary approach that takes into account the human element of the network. The three aspects of cyber that are addressed are: 1) vulnerabilities and risks of cyber networks to malicious activities, 2) anticipating, detecting, and analyzing malicious activities, and 3) agile cyber maneuver to thwart and defeat malicious activities. Overarching goals of cyber security are to significantly decrease the adversary's return on investment when considering cyber attack on Army networks, and minimizing the impact on (Army) network performance related to implementing cyber security. The CRA research creates a framework that effectively integrates the knowledge of cyber assets and potential adversary capabilities and approaches, and provides defense mechanisms that dynamically adjust to changes related to mission, assets, vulnerability state, and defense mechanisms.												
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) in Adelphi and Aberdeen Proving Grounds, MD.												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2013	FY 2014	FY 2015	
Title: Cyber Security Collaborative Research Alliance									-	3.008	4.200	
Description: The Cyber Security Collaborative Research Alliance (CRA) supports basic research to enable capabilities for rapid development and adaptation of cyber tools for dynamically assessing cyber risks, detecting hostile activities on friendly networks, and supporting agile maneuver in cyber space in spite of the continuous evolution and emergence of novel threats.												
FY 2014 Plans:												
Competitively select a consortium consisting of academia, industry and government researchers to advance the theoretical foundations of cyber science in the context of Army networks; investigate new holistic conceptualizations and definitions of risk, resiliency and robustness under an adversarial setting; study and create theory and techniques for effective non-signature based detection of advanced persistent threats; develop mathematical theories and models leading to algorithms to affect a desired												

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601104A / <i>University and Industry Research Centers</i>	<b>Project (Number/Name)</b> EA6 / <i>Cyber Collaborative Research Alliance</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
maneuver end-state in dynamic environments and deliberate obfuscation attempts by the adversary; and explore theoretical models of the cyber defender leading to improved defender effectiveness.			
<b>FY 2015 Plans:</b> Will develop theories and models relating fundamental properties and features of dynamic risk assessment algorithms to the fundamental properties of dynamic cyber threats, Army's networks, and defensive mechanisms taking into account the context of the mission; develop theories and models relating properties and capabilities of cyber threat detection and recognition processes/mechanisms to properties of malicious activity and of Army networks; develop theories and models to support planning and control of cyber maneuver (i.e., "maneuver" in the space of network characteristics and topologies) that would describe how control and the end-state of the maneuver are influenced by fundamental properties of threats - such as might be rapidly inferred from limited observations of a new, recently observed threat; and develop a theoretical understanding of the socio-cognitive factors that impact the decision making of the user/Soldier, defender/analyst, and adversary.			
<b>Accomplishments/Planned Programs Subtotals</b>		-	3.008
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b> N/A			
<b>E. Performance Metrics</b> N/A			



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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601104A / University and Industry Research Centers				Project (Number/Name) F17 / Neuroergonomics Collaborative Technology Alliance			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
F17: Neuroergonomics Collaborative Technology Alliance	-	4.680	5.378	3.991	-	3.991	5.293	5.372	5.465	5.562	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
Note Not applicable for this item.												
A. Mission Description and Budget Item Justification												
This project fosters research through the Cognition and Neuroergonomics Collaborative Technology Alliance (CTA), a competitively selected industry and university consortium, to leverage world-class research in support of future force and Army transformation needs. Escalating levels of complexity and uncertainty on the current and future battlefield present conditions which have never existed before now. Solution strategies and approaches must be developed or tailored. The emerging field of neuroergonomics, which seeks to understand the brain at work and to leverage that understanding to optimize system design, offers tremendous potential for providing the solutions needed to meet the needs of Army forces in the future. This CTA addresses the solution strategies and approaches needed to design systems to fully exploit investments in revolutionary technological advances in areas such as robotics, microelectronics, and computer and network information systems. These technologies present significant opportunities to enhance Army mission capabilities, but impose significant burdens on the human brain, which will ultimately limit Soldier-system effectiveness, sustainability, and survivability. The technical barriers associated with this project include: immature knowledge base to guide the neuroergonomic approach to human-system integration; inadequate capabilities to sense and extract information about brain activity in dynamic, operational environments; lack of valid measures to robustly and uniquely characterize operationally-relevant cognitive performance; lack of techniques for integrating advanced understandings of brain activity into systems designs, including real-time use of measures of cognitive behavior as system inputs and the capability to account for individual differences in maximizing Soldier-system performance. This CTA conducts an intensive and accelerated program to formulate, validate, and transition basic research findings through multi-dimensional approaches focused in three areas: understanding fundamental principles underlying Soldier neurocognitive performance in operational environments, advancing computational approaches for the analysis and interpretation of neural functioning, and fundamental advancement in neurotechnologies that enhance Soldier-system interactions and performance.												
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) in Adelphi, MD.												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2013	FY 2014	FY 2015	
Title: Neurocognitive performance in operational environments									1.695	2.047	1.517	

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014		
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / University and Industry Research Centers	Project (Number/Name) F17 / Neuroergonomics Collaborative Technology Alliance		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
<p><b>Description:</b> This effort is intended to understand fundamental principles underlying Soldier neurocognitive performance in operational environments.</p> <p><b>FY 2013 Accomplishments:</b> Completed execution of large scale simulation evaluations to generate data for addressing issues of individual differences in neurocognitive performance; and transitioned lessons learned from evaluation of formal models in simulation assessments to inform the development of a second phase of evaluation with increased military relevance/realism</p> <p><b>FY 2014 Plans:</b> Develop and transition lessons learned on individual differences in neurocognitive performance from large scale simulation evaluations to second phase of evaluation with increased military relevance/realism; and develop simulation evaluations with increased military relevance/realism to evaluate formal models of neurocognitive performance issues of individuals in neurocognitive performance</p> <p><b>FY 2015 Plans:</b> Will evaluate neurocognitive performance using novel scenarios of increasing military relevance to determine feasibility of military applications; and identify methods of mathematical processing and evaluate utility for interpreting brain activity recordings under conditions that demand complex neural functioning of operationally relevant tasks.</p>				
<p><b>Title:</b> Computational neural analysis</p> <p><b>Description:</b> This effort advances computational approaches for the analysis and interpretation of neural functioning.</p> <p><b>FY 2013 Accomplishments:</b> Completed the analysis of large-scale simulations including further elaboration of models and computational methods for assessing neurocognitive performance and identifying predictive features of inter- and intra-subject variability; and designed extensions of databases to enable further analysis and modeling of individual differences in neurocognitive function.</p> <p><b>FY 2014 Plans:</b> Conduct data mining explorations of large-scale simulation evaluations using novel computational methods for identification and clustering of predictive features of inter- and intra-subject variability; and implement extensible database designs for enabling data exploration and modeling of individual differences in neurocognitive function.</p> <p><b>FY 2015 Plans:</b> Will use information obtained from data mining explorations of large-scale simulation for development of improved algorithms for brain computer interaction technologies that better account for variability among individuals.</p>		1.485	1.606	1.197
<p><b>Title:</b> Neurotechnologies</p>		1.500	1.725	1.277

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601104A / <i>University and Industry Research Centers</i>	<b>Project (Number/Name)</b> F17 / <i>Neuroergonomics Collaborative Technology Alliance</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p><b>Description:</b> This effort provides a fundamental advancement in neurotechnologies that enhance Soldier-system interactions and performance.</p> <p><b>FY 2013 Accomplishments:</b>  Matured and assessed online signal processing methods for analysis of EEG data; validated methods and sensor performance for remote monitoring of Soldier fatigue; and implemented and evaluated algorithms for a neuro-computer vision system for automated environmental appraisal; implemented and assessed user feedback / alerting system relating to saliency and attention modeling, object detection, object tracking for automation and Soldier training technology design.</p> <p><b>FY 2014 Plans:</b>  Refine methods, sensor performance, and system designs for on-line monitoring and assessment of Soldier fatigue and neurocognitive state; validate performance of algorithms for a neuro-computer vision for automated environment appraisal; and evaluate and validate methods for Soldier monitoring and assessment in human-computer interaction technologies for Soldier intentional and target detection performance and adaptive automation systems</p> <p><b>FY 2015 Plans:</b>  Will pursue adaptation of neuroimaging technologies to enhance functionality in complex environments; and develop technical capabilities for identification of brain activity in realistic environments, including hardware and software algorithms robust to environmental and user-induced artifacts.</p>			
<b>Accomplishments/Planned Programs Subtotals</b>		4.680	5.378
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601104A / <i>University and Industry Research Centers</i>				Project (Number/Name) H04 / <i>HBCU/MI Programs</i>			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H04: <i>HBCU/MI Programs</i>	-	2.494	2.959	2.105	-	2.105	1.901	1.944	1.995	2.049	-	-

# The FY 2015 OCO Request will be submitted at a later date.

## Note

FY 14 OSD funding for Historically Black Colleges and Universities and Minority Institutions was realigned from the RDT&E, Army appropriation to RDT&E, Defense-wide appropriation. Army specific efforts continue to be funded in this project.

## A. Mission Description and Budget Item Justification

This project supports basic research through the Partnership in Research Transition (PIRT) program, the Army's research initiative focused on partnerships with Historically Black Colleges and Universities and Minority Institutions (HBCU/MI), and provides support to Department of Defense (DoD) Historically Black Colleges and Universities and Minority Institutions (HBCU/MI) program providing support for research and collaboration with DoD facilities and personnel for research and collaboration with DoD facilities and personnel. The focus of this effort is to enhance programs and capabilities of a select number of high-interest scientific and engineering disciplines through innovative research at Centers of Excellence (CoE) established at Historically Black Colleges and Universities. These COEs work with Army, industrial, and other academic partners to accelerate the transition from the research phase to technology demonstration. In addition, these CoEs recruit, educate, and train outstanding students and post-doctoral researchers in science and technology areas relevant to the Army.

Work in this project is fully coordinated with the Office of Secretary of Defense program manager for HBCU/MI programs.

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) in Adelphi, MD.

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

	<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>
<b>Title:</b> Centers of Excellence for Battlefield Capability Enhancements (BCE)	2.494	2.959	2.105
<b>Description:</b> Five new Partnership in Research Transition (PIRT) Centers of Excellence were established in 2011 at: Hampton Univ. (Lower Atmospheric Research Using Lidar Remote Sensing); NCA&T State Univ. (Nano to Continuum Multi-Scale Modeling Techniques and Analysis for Cementitious Materials Under Dynamic Loading); Delaware State Univ. (Center for Advanced Algorithms); Howard Univ.(2) (Bayesian Imaging and Advanced Signal Processing for Landmine and IED Detection Using GPR, and Extracting Social Meaning From Linguistic Structures in African Languages). These Centers were selected to: enhance programs and capabilities through Army-relevant, topic-focused, near-transition-ready innovative research; strengthen the			

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601104A / <i>University and Industry Research Centers</i>	<b>Project (Number/Name)</b> H04 / <i>HBCU/MI Programs</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
capacity of the Historically Black Colleges and Universities (HBCUs) to provide excellence in education; and to conduct research critical to the national security functions of the DoD.			
<b>FY 2013 Accomplishments:</b> Continued research efforts at the PIRT Centers of Excellence; and conducted major program-wide review of all center research progress.			
<b>FY 2014 Plans:</b> Continue research efforts at PIRT Centers of Excellence that began in FY11 and continued in FY12 and FY13, for centers showing sufficient progress toward research goals and transition.			
<b>FY 2015 Plans:</b> Will continue to support research at PIRT Centers of Excellence and collaboration with Army Labs and other institutions of higher learning to transition science and innovation to enhance warfighting capabilities of U.S. Soldiers.			
<b>Accomplishments/Planned Programs Subtotals</b>		2.494	2.959
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			

# UNCLASSIFIED

Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601104A / <i>University and Industry Research Centers</i>				Project (Number/Name) H05 / <i>Institute For Collaborative Biotechnologies</i>			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H05: <i>Institute For Collaborative Biotechnologies</i>	-	10.834	12.451	8.000	-	8.000	6.532	6.645	6.777	6.921	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
<b>A. Mission Description and Budget Item Justification</b> This project supports research at the Army's Institute for Collaborative Biotechnologies (ICB), led by the University of California-Santa Barbara, and two major supporting partners, the California Institute of Technology and the Massachusetts Institute of Technology. The ICB was established as a University Affiliated Research Center (UARC) to support leveraging biotechnology for: advanced sensors; new electronic, magnetic, and optical materials; and information processing and bioinspired network analysis. The objective is to perform sustained multidisciplinary basic research supporting technology to provide the Army with biomolecular sensor platforms with unprecedented sensitivity, reliability, and durability; higher-order arrays of functional electronic and optoelectronic components capable of self-assembly and with multi-functions; and new biological means to process, integrate, and network information. These sensor platforms will incorporate proteomics (large scale study of proteins) technology, DNA sequence identification and detection tools, and the capability for recognition of viral pathogens. A second ICB objective is to educate and train outstanding students and post doctoral researchers in revolutionary areas of science to support Army Transformation. The ICB has many industrial partners, such as IBM and SAIC, and has strong collaborations with Argonne, Lawrence Berkley, Lawrence Livermore, Los Alamos, Oak Ridge, and Sandia National Laboratories, the Army's Institute for Soldier Nanotechnologies, the Institute for Creative Technologies, and U.S. Army Medical Research and Materiel Command (MRMC) laboratories.  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 extramurally by the U.S. Army Research Laboratory (ARL) in Adelphi, MD.												
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>									FY 2013	FY 2014	FY 2015	
<b>Title:</b> Institute for Collaborative Biotechnologies									9.595	11.007	7.200	
<b>Description:</b> Perform sustained multidisciplinary basic research supporting technology to provide the Army with bio-inspired materials and biomolecular sensor platforms.												
<b>FY 2013 Accomplishments:</b> Investigated engineering glucosidases (enzyme class responsible for catalyzing breakdown of plant and other biomaterials into nutrients) and assessed bio- mixtures with thermally-stable cellulases for potential future applications in biofuel production; and researched concepts and designs for bio-inspired energy-dispersive composites.												
<b>FY 2014 Plans:</b>												

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601104A / <i>University and Industry Research Centers</i>	<b>Project (Number/Name)</b> H05 / <i>Institute For Collaborative Biotechnologies</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
Investigate methods for designing and characterizing bio-inspired materials such as exploring new architectures for mechanical strength which can form the basis for new protective materials for the Soldier; expand computational tools that allow for improved selection of engineered enzymes as candidates for potential use in biofuel production; design biomolecular circuitry and control systems within cells to enable rapid detection and response to environmental effects; and examine the effects of oligoelectrolyte insertion within the membranes of a variety of bacterial species to better determine the effects of membrane modification on the potential for generating power from wastewater remediation.			
<b>FY 2015 Plans:</b> Will show independent tuning of the temperature coefficient of resistance and noise to improve signal to noise ratio of room temperature infrared detectors; show electrically injected, high-speed 1.55 $\mu\text{m}$ nanoscale lasers on a silicon (Si) platform for potential gains in energy efficiency of computational and sensor systems; show that plasmonic antennas can mitigate efficiency degradation for efficient data communications and energy harvesting; and create and investigate a novel sensor based on optical dark modes in nanorods for use in biomolecule, chemical sensing, and near-field imaging.			
<b>Title:</b> Neuroscience  <b>Description:</b> Perform multidisciplinary basic research in the area of neuroscience.		1.239	1.444
<b>FY 2013 Accomplishments:</b> Studied genetic, anatomic, and strategic differences of cognitive performance using EEG and functional magnetic resonance imaging (fMRI) methods to characterize individual differences of brain activity; and began design and validation of new methods to characterize brain anatomic networks and dynamical patterns relevant to neuroimaging studies.			
<b>FY 2014 Plans:</b> Assess the relationship between brain structural and functional connections with behavior to gain a better understanding of the relationship between a Soldier's hardwired brain structure and cognitive ability; assess whether neural measurements (e.g., functional magnetic resonance imaging or electroencephalography) can predict the performance of an individual to correctly perceive and detect targets placed at unusual locations within natural environments; and identify neural and physiological biomarkers associated with adaptive cognitive capacity under stress and fatigue			
<b>FY 2015 Plans:</b> Will utilize psychophysics, mathematical modeling and cutting-edge neuroscientific measurements to explore the neural components underlying perceptual decision making, indecisiveness, learning capabilities and attentional states while performing complex visual tasks, which may ultimately lead to new methods, tools, and models to enhance warfighter performance; and			
			0.800

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601104A / <i>University and Industry Research Centers</i>	<b>Project (Number/Name)</b> H05 / <i>Institute For Collaborative Biotechnologies</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
explore the organizational principles governing the structure and topology of brain networks and analyze brain imaging data that, in the long term, may enable the design of improved training protocols to reduce unwanted maladaptive behaviors.			
<b>Accomplishments/Planned Programs Subtotals</b>		10.834	12.451
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b> N/A			
<b>E. Performance Metrics</b> N/A			



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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601104A / <i>University and Industry Research Centers</i>				Project (Number/Name) H09 / <i>Robotics CTA</i>			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H09: <i>Robotics CTA</i>	-	4.955	6.646	5.844	-	5.844	5.598	5.682	5.780	5.884	-	-

# The FY 2015 OCO Request will be submitted at a later date.

## A. Mission Description and Budget Item Justification

This project supports a collaborative effort between the competitively selected industry and university consortium, the Robotics Collaborative Technology Alliance (CTA), and the U.S. Army Research Laboratory (ARL) for the purpose of leveraging world-class research in support of the future force and Army transformation needs. This project conducts basic research in areas that will expand the capabilities of intelligent mobile robotic systems for military applications with a focus on enhanced, innate intelligence, ultimately approaching that of a dog or other intelligent animal, to permit unmanned systems to function as productive members of a military team. Research is conducted in machine perception, including the exploration of sensor phenomenology, and the investigation of basic machine vision algorithms enabling future unmanned systems to better understand their local environment for enhanced mobility and tactical performance; intelligent control, including the advancement of artificial intelligence techniques for robot behaviors permitting future systems to autonomously adapt, and alter their behavior to dynamic tactical situations; understanding the interaction of humans with machines focusing upon intuitive control by Soldiers to minimize cognitive burden; dexterous manipulation of the environment by unmanned systems; and unique modes of mobility to enable unmanned systems to seamlessly navigate complex or highly constrained three dimensional environments. The program will conduct both analytic and validation studies.

Work in this projects builds fundamental knowledge for and complements the companion applied technology program, PE 0602120A, project TS2 (Robotics).

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) at the Aberdeen Proving Ground, MD.

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

	<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>
<b>Title:</b> Autonomous Systems	4.955	6.646	5.844
<b>Description:</b> Explore opportunities enabling revolutionary, autonomous, and highly mobile systems for the future force. Research focuses on unmanned systems operating as a team with human supervisors and displaying a high degree of adaptability to dynamic environmental and tactical situations.			
<b>FY 2013 Accomplishments:</b>			

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601104A / <i>University and Industry Research Centers</i>	<b>Project (Number/Name)</b> H09 / <i>Robotics CTA</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p>Investigated incorporation of learning into recognition of relationships between both static and dynamic elements of the environment; explored mechanisms for common understanding between humans and machines to enable effective teaming; and examined fundamental principles and mechanics of grasping, manipulation, and ambulation.</p> <p><b>FY 2014 Plans:</b> Expand investigation of learning and recognition of relationships to include more complex dynamic environments and adversarial intent; continue investigation of cognitive approaches to machine perception and the creation of a shared mental model to reduce reliance upon communication between humans and robots; continue exploration of whole body (dynamic) manipulation of objects in the environment; and continue exploration of novel ground locomotion techniques to enable rapid mobility in three-dimensional and confined environments</p> <p><b>FY 2015 Plans:</b> Will expand upon utilization of learning to conduct semantic labeling of objects and behaviors; expand upon the concept of a hybrid cognitive-metric architecture, including perceptual and reasoning skills, to enable teaming of humans and unmanned systems; and explore novel modes of mobility, including legs and snake-like motion, to enable efficient, effective mobility in complex three-dimensional environments.</p>			
<b>Accomplishments/Planned Programs Subtotals</b>		4.955	6.646
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601104A / <i>University and Industry Research Centers</i>				Project (Number/Name) H50 / <i>Network Sciences Cta</i>			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H50: <i>Network Sciences Cta</i>	-	11.573	14.193	11.500	-	11.500	11.196	11.364	11.560	11.771	-	-

# The FY 2015 OCO Request will be submitted at a later date.

## A. Mission Description and Budget Item Justification

This project supports a competitively selected university and industry consortium, the Network Sciences Collaborative Technology Alliance (NS CTA), formed to leverage commercial research investments to provide solutions to Army's requirements for robust, survivable, and highly mobile wireless communications networks, while meeting the Army's needs for a state-of-the-art wireless mobile communications networks for command-on-the-move. The NS CTA performs foundational, cross-cutting network science research leading to: a fundamental understanding of the interplay and common underlying science among social/cognitive, information, and communications networks; determination of how processes and parameters in one network affect and are affected by those in other networks; and prediction and control of the individual and composite behavior of these complex interacting networks. This research will lead to optimized human performance in network-enabled warfare and greatly enhanced speed and precision for complex military operations. The CTA facilitates the exchange of people among the collaborating organizations to provide cross-organizational perspectives on basic research challenges, as well as the use of state-of-the-art facilities and equipment at the participating organizations. Beginning in FY12, all funds from PE 61104/project J22 were realigned to this project.

Work in this project builds fundamental knowledge for and accelerates the transition of communications and networks technology to PE 0602783A (Computer and Software 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) in Adelphi, MD.

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

	<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>
<b>Title:</b> Network Sciences Collaborative Technology Alliance (NS CTA)	11.573	14.193	10.500
<b>Description:</b> The Network Sciences CTA focuses on four major research areas: Information Networks, Communication Networks, Social/Cognitive Networks, and Interdisciplinary Research to develop a fundamental understanding of the ways that information, social/cognitive, and communications networks can be designed, composed, and controlled to dramatically increase mission effectiveness and ultimately enable humans to effectively exploit information for timely decision-making. Information Networks research develops the fundamental understanding of autonomous network activities and its linkage to the physical and human domains as related to human decision making within the networked command and control (C2) structure. Social/Cognitive Networks research is developing the fundamental understanding of the interplay of the various aspects of the social and cognitive networks with information and communications. Communications Networks research is developing the foundational techniques to			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014		
Appropriation/Budget Activity 2040 / 1		R-1 Program Element (Number/Name) PE 0601104A / University and Industry Research Centers		Project (Number/Name) H50 / Network Sciences Cta	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>			<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>
model, analyze, predict, and control the behavior of secure tactical communication networks as an enabler for information and C2 networks. Integration is focused on achieving an integrated Information Networks, Social/Cognitive Networks, Communications Networks research program that significantly enhances the fundamental understanding of the underlying science of networks.					
<b>FY 2013 Accomplishments:</b> Using human-in-the-loop and simulation-emulation experiments, along with collections of empirical data, extended, calibrated and validated theories and models of complex interactions between social, cognitive, information and communication networks, particularly in the evolution and propagation of information, trust and beliefs in insurgent-civilian populations, as well as in battle command decision-making under dynamic conditions and adversarial attacks.					
<b>FY 2014 Plans:</b> Explore mathematical representations of dynamic communications, information, and social networks that enable the analysis of their joint behavior; develop techniques for discovering node roles and hierarchical structures in noisy, uncertain social networks, and techniques to maximize information (not bits) delivered based on quality of information needs and the context of decisions (semantics); and develop techniques for social and information-aware caching to improve performance and robustness of composite networks. These efforts will result in analytical techniques for the design of better Army tactical networks that are more resilient in disruptive environments.					
<b>FY 2015 Plans:</b> Will develop an understanding and associated metrics representative of the relationship between security and network performance in the context of tactical and coalition networks by developing models of socio-cognitive trust and quantification of trust relationships and risk management; develop theories of quality of information, employing human-in-the-loop analysis, to model the tradeoffs between quality of information and efficiency of analysis on affecting the accuracy of analysis and data interpretation; and develop mathematical representations for the quality of information of static and dynamic data and its effectiveness for situational awareness. These efforts will result in the identification of data for more accurate situational awareness.					
<b>Title:</b> Mobile Network Modeling Institute			-	-	1.000
<b>Description:</b> This research focuses on novel computational models, data structures, computational architectures and techniques that enable predictions of performance and stability of large, complex communications networks. It takes into account the impact of Soldiers' information needs and modalities of access and use of communication networks in complex adversarial environments, high mobility, and adversarial effects such as jamming or cyber attacks. Also considered are computational modeling approaches that capture dynamics of information that flows through the network and/or is stored within the network, and undergoes continual changes as new information arrives and other information ages or is refuted/superseded by newly arrived information; and the impact of clouds and local tactical cloudlets on network behaviors.					

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601104A / <i>University and Industry Research Centers</i>	<b>Project (Number/Name)</b> H50 / <i>Network Sciences Cta</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<b><i>FY 2015 Plans:</i></b> Will investigate approaches to computational modeling of large-scale networks that incorporate alternative routing techniques, such as trust-based or quality-based routing schemes; use computational experiments to inform study of pathological phenomena that might be induced in large-scale network behaviors by such novel schemes with unknown ramifications; explore impact of such models on existing computational architectures and their performance; and identify constraints on potential uses of alternative routing schemes on applicability of available computational modeling techniques.			
<b>Accomplishments/Planned Programs Subtotals</b>		11.573	14.193
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601104A / University and Industry Research Centers				Project (Number/Name) H53 / Army High Performance Computing Research Center			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H53: Army High Performance Computing Research Center	-	4.054	4.899	5.392	-	5.392	5.700	5.785	5.885	5.993	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
Note Not applicable for this item.												
A. Mission Description and Budget Item Justification												
This project supports critical research at the Army High Performance Computing Research Center (AHPCRC). Research at the AHPCRC is focused on the Lightweight Combat Systems Survivability, computational nano- and bio-sciences, computational battlefield network and information sciences including evaluating materials suitable for armor/anti-armor and sensor applications, defense from chemical and biological agents, and associated enabling technologies requiring computationally intensive algorithms in the areas of combat systems survivability, battlefield network sciences, chemical and biological defense, nanoscience and nanomechanics, and computational information sciences, scientific visualization enabling technologies that support the future force transition path. This project also supports the Robotics Collaborative Technology Alliance (0601104/project H09) which explores new opportunities to enable revolutionary autonomous mobility of unmanned systems for the future force. This research is an integral part of the larger Army Robotics Program and feeds technology into Robotics Technology (0602120A/project TS2). The project also addresses research focusing on unmanned systems operating as a team with human supervisors and displaying a high degree of adaptability to dynamic environmental and tactical situations.												
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) in Adelphi, MD.												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2013	FY 2014	FY 2015	
Title: AHPCRC									4.054	4.899	5.392	
Description: The AHPCRC research mission is to advance computational science and its application to critical Army technologies through an Army-university-industry collaborative research program in such areas as combat systems survivability, and chemical and biological defense.												
FY 2013 Accomplishments: Continued to develop reduced order modeling (ROM) concepts for underbody blast problems by developing and solving high-fidelity fully-coupled blast-structure interaction applications and then developing appropriate complex mathematical formulations												

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601104A / <i>University and Industry Research Centers</i>	<b>Project (Number/Name)</b> H53 / <i>Army High Performance Computing Research Center</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p>for accurate reduced models; developed scalable approaches for drug delivery through non-fluidic methods for Army medical applications; validated preliminary simulations for all electron battery; validated ion of back projection applications for battle command applications on new hybrid computing architecture; and investigated scalable algorithms for large-scale graphene modeling software and associated validation approaches with U.S. Army Research Laboratory experiments.</p> <p><b>FY 2014 Plans:</b> Implement ROM approach for underbody blast application including occupant, improvised explosive device (IED) blast, and vehicle structural response; support verification and validation of ROM approach (with U.S. Army Research Development and Engineering Centers); implement nano-fluidic based multi-scale/multi-physics approaches on scalable computers and support validation of this work for blood flow and drug delivery (with U.S. Army Medical Research and Materiel Command (MRMC)); develop domain specific language (DSL) for finite element-based approaches; explore emerging hybrid and memory hierarchy computer systems; and support education and outreach activities formerly funded in 0605803/project 731.</p> <p><b>FY 2015 Plans:</b> The goal of the ROM for underbody blast project is to develop predictive capability for practical underbody blast applications. Earlier work demonstrated feasibility by adopting DoD engineering software Conventional Weapons Effects (ConWep). This phase will develop highly non-linear mathematical formulations and implement fully coupled, high-fidelity blast-structure interaction problem-solving. A number of new energy conserving algorithms in the context of ROM will be developed and implemented for this multi-physics transient application. Will validate, verify and transition research software working with Army partners; continue exascale algorithms development under LISZTFE (domain specific finite element code) environment; investigate a new class of direct solvers, called fast direct solvers (FDS), which use low-rank-matrix approximations to reduce the computational complexity; and transition software developed for blood transfusion and continue new scalable algorithmic development research for simulating inhalation of toxic agents for realistic patient-specific geometric features.</p>			
<b>Accomplishments/Planned Programs Subtotals</b>		4.054	4.899
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601104A / University and Industry Research Centers				Project (Number/Name) H54 / Micro-Autonomous Systems Technology (MAST) CTA			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H54: Micro-Autonomous Systems Technology (MAST) CTA	-	7.078	8.092	7.303	-	7.303	7.735	7.851	7.987	8.131	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
Note Not applicable for this item.												
A. Mission Description and Budget Item Justification												
This project fosters basic research through the Micro Autonomous Systems and Technology (MAST) Collaborative Technology Alliance (CTA), a competitively selected industry-university consortium which leverages world-class research necessary to address future force and Army Transformation needs. The CTA links a broad range of government technology agencies, as well as industrial and academic partners with the U.S. Army Research Laboratory (ARL). The MAST CTA focuses on innovative research in four main technical areas related to the coherent and collaborative operation of multiple micro autonomous platforms: microsystem mechanics, processing for autonomous operation, microelectronics, and platform integration. Payoff to the warfighter will be advanced technologies to support future force requirements in situational awareness. The CTA facilitates the exchange of people among the collaborating organizations to provide cross-organizational perspectives on basic research challenges, and to make available to the Alliance state-of-the-art facilities and equipment at the participating organizations.												
Work in this project complements and is fully coordinated with the U.S. Army Tank and Automotive Research, Development, and Engineering Center (TARDEC); the U.S. Army Natick Soldier Research, Development, and Engineering Center (NSRDEC); and the U.S. Special Operations Command (SOCOM).												
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) in Adelphi, MD.												
B. Accomplishments/Planned Programs (\$ in Millions)												
Title: Micro Autonomous Systems Technology CTA									FY 2013	FY 2014	FY 2015	
Description: Enhance tactical situational awareness in urban and complex terrain by enabling the autonomous operation of a collaborative ensemble of multifunctional mobile microsystems.									7.078	8.092	7.303	
FY 2013 Accomplishments:												



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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601104A / <i>University and Industry Research Centers</i>	<b>Project (Number/Name)</b> H54 / <i>Micro-Autonomous Systems Technology (MAST) CTA</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p>Experimentally validated the ability of small air platforms to navigate autonomously in disturbed air and develop technology to allow micro ground platforms to move over rough terrain; and conducted experiments on the ability of small air and ground platforms to work collaboratively to enter and explore an urban structure.</p> <p><b>FY 2014 Plans:</b> Study and develop bio-inspired robotic platform mobility and control methods for Micro Autonomous Systems (MAS) in real world environments, sensors for on-board state estimation and perception, architectures and algorithms for heterogenous teaming; study trades between increased risk and uncertainty and increased operational tempo; and conduct joint experiments on emerging technology to assess the ability of small air and ground platforms to work collaboratively to enter and explore urban and complex three dimensional (3-D) environments.</p> <p><b>FY 2015 Plans:</b> Will investigate bio-inspired air and ground robotic platform mobility and control methods (for MAS in real world environments), sensors (for on-board state estimation and perception for size, weight, power, and processing constrained MAS), and architectures and algorithms (for heterogenous teaming, communications, and navigation); study trades between increased risk, uncertainty and increased operational tempo; and conduct joint experiments on emerging MAS technology to assess the ability to support rapid and mobile Intelligence, Surveillance, and Reconnaissance for the Soldier in complex 3-D environments.</p>			
<b>Accomplishments/Planned Programs Subtotals</b>		7.078	8.092
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601104A / University and Industry Research Centers				Project (Number/Name) H59 / International Tech Centers			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H59: International Tech Centers	-	6.615	7.605	6.097	-	6.097	7.027	7.129	7.251	7.384	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
<b>Note</b> Not applicable for this item.												
<b>A. Mission Description and Budget Item Justification</b>												
This project funds the International Technology Centers (ITCs), the Foreign Technology (and Science) Assessment Support (FTAS) program, and the Basic Research Center for Network Science located at the United States Military Academy (USMA).												
The nine ITCs located in Australia, the United Kingdom, Canada, France, Germany, Japan, Chile, Argentina, and Singapore support the Army's goals of providing the best technology in the World to our Warfighters by leveraging the Science and Technology (S&T) investments of our international partners. The ITCs perform identification and evaluation of international technology programs to assess their potential impact on the Army's S&T investment strategy. ITC 'technology finds' are submitted as technology information papers (TIPs) to various Army S&T organizations for evaluation and consideration for further research and development. The ITC TIPs also serve as input into the international section of the Army S&T Master Plan. The FTAS program builds upon the TIPs submitted by the ITCs. In some cases the TIP is truly unique and may well meet an Army requirement or potentially support ongoing Army S&T investments. In such cases, the FTAS program can provide initial resources (seed money) to fund basic research in these technology areas identified by the TIPs as having potential relevance to the Army's S&T plan. The research will provide information useful in making early assessments of the technology's potential contributions to the Army's S&T strategy.												
Work in this project related to the USMA Basic Research Center for Network Science is fully coordinated with and complementary to PE 0601104/Project H50 (Network Science CTA).												
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 Headquarters, U.S. Army Research, Development and Engineering Command (RDECOM), the U.S. Army Research Laboratory (ARL) in Adelphi, MD, and the United States Military Academy, NY.												
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>									<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>	
<b>Title:</b> International Technology Centers (ITC)									5.743	6.598	5.703	
<b>Description:</b> Funding is provided for the following effort.												

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601104A / <i>University and Industry Research Centers</i>	<b>Project (Number/Name)</b> H59 / <i>International Tech Centers</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<b><i>FY 2013 Accomplishments:</i></b> Continued to solicit projects and build on the success of the Foreign Technology (and Science) Assessment Support (FTAS) Program; and continued to enhance and refine technology search capabilities using customer feedback (U.S. Army Research Development and Engineering Centers (RDECs), Program Managers (PMs) and labs) to focus on near and long term capabilities.			
<b><i>FY 2014 Plans:</i></b> Continue to solicit projects and build on the success of the FTAS Program; and continue to enhance and refine technology search capabilities using customer feedback (RDECs, PMs and labs) to focus on near and long term capabilities.			
<b><i>FY 2015 Plans:</i></b> Will continue to solicit projects and build on the success of the FTAS Program; continue to enhance and refine technology search capabilities using customer feedback (RDECs, PMs and labs) to focus on near and long term capabilities.			
<b><i>Title:</i></b> Basic Research Center in Network Science at the United States Military Academy (USMA) <b><i>Description:</i></b> Network science research at USMA in coordination with the Network Science CTA (0601104/project H50).		0.872	1.007
<b><i>FY 2013 Accomplishments:</i></b> Investigated cooperation networks and how those theoretical frameworks can improve systems and organizations; continued to research biological networks and implement those insights towards improvement in communication and organizational networks; and studied economic cascading events in order to better understand obstacles to the economic development of a country.			
<b><i>FY 2014 Plans:</i></b> Develop an algorithm based on the convergence of "vertex probabilities" that will improve the ability to "influence" a social network; refine initial findings concerning cooperation networks and how these theoretical frameworks can improve systems and organizations; study network topologies and features linked to network vulnerabilities and efficient network-level power management; and study development of a new network classification model that assists policy makers with economic development strategy.			
<b><i>FY 2015 Plans:</i></b> Will continue to refine algorithms based on the convergence of "vertex probabilities" to improve the ability to "influence" networks; and continue to refine advances in cooperation networks to include how these theoretical frameworks can improve systems and organizations.			
<b>Accomplishments/Planned Programs Subtotals</b>		6.615	7.605
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / <i>University and Industry Research Centers</i>	Project (Number/Name) H59 / <i>International Tech Centers</i>
C. Other Program Funding Summary (\$ in Millions)		
Remarks		
D. Acquisition Strategy		
N/A		
E. Performance Metrics		
N/A		

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601104A / University and Industry Research Centers				Project (Number/Name) H64 / MATERIALS CENTER			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
H64: MATERIALS CENTER	-	0.738	-	-	-	-	-	-	-	-	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
Note Not applicable for this item.												
A. Mission Description and Budget Item Justification												
This project concentrates scientific resources on materials research for lightweight vehicle protection and is executed through Cooperative Research Agreements (CRAs). The effort funds collaborative research in three Materials Science and Engineering Research Areas (MSERAs): Composite Materials Research; Advanced Metals and Ceramics Research; and Polymer Materials Research. Each MSERA pursues thematic research thrusts that address topics pertinent to lightweight vehicle protection and that are aligned with the Army's strategic materials research vision enabling long term synergistic collaboration between the U.S. Army Research Laboratory (ARL) scientists and university researchers. The Materials Cooperative Research Agreements provide for mutual exchange of personnel and sharing of research facilities with the University of Delaware, Johns Hopkins University, Rutgers University, Drexel University, and Virginia Polytechnic Institute and State University. Lightweight, multi-functional composites, advanced armor ceramics, dynamic response of metals, protective polymer, and hybrid systems are emphasized.												
Work in this project built fundamental knowledge supporting ARL in-house materials research projects (PE 0601102A/ project H42) and accelerated the transition of technology to PE 0602105A (Materials Technology). In FY12, work in this effort concluded. In FY13, the advanced materials emphasis for the Army focuses on multi-disciplinary, multi-scale materials behavior in extreme environments conducted in PE 0601104A/project VS2 (Multi-Scale Materials Modeling Centers).												
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) in Aberdeen Proving Ground, MD.												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2013	FY 2014	FY 2015	
Title: Materials Research for Vehicle Protection									0.738	-	-	
Description: Materials research for vehicle protection performs research and exploits promising breakthroughs in multi-functional composites, advanced armor ceramics, dynamic response of metals, protective polymers, and hybrid systems to enable revolutionary vehicle protection.												
FY 2013 Accomplishments:												

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601104A / <i>University and Industry Research Centers</i>	<b>Project (Number/Name)</b> H64 / <i>MATERIALS CENTER</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
Finalized mechanism-based multi-scale approach to microstructure design for dynamic applications; and developed understanding of size effects in magnesium vis-a -vis etching and orientation for quantifying demonstrated enhanced mechanical properties. Completed effort in FY13.			
<b>Accomplishments/Planned Programs Subtotals</b>		0.738	-
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b> N/A			
<b>E. Performance Metrics</b> N/A			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014			
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601104A / University and Industry Research Centers				Project (Number/Name) H73 / Automotive Research Center (ARC)				
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost	
H73: Automotive Research Center (ARC)	-	3.649	4.193	3.157	-	3.157	3.156	3.203	3.258	3.318	-	-	
# The FY 2015 OCO Request will be submitted at a later date.													
<b>Note</b> Not applicable for this item.													
<b>A. Mission Description and Budget Item Justification</b> This project fosters basic research in novel, high payoff technologies that can be integrated into Army ground platforms. The Center of Excellence for Automotive Research is part of the basic research component of the National Automotive Center (NAC), a business group within the US Army Tank-Automotive Research, Development, and Engineering Center (TARDEC). The Center of Excellence for Automotive Research is an innovative university/industry/government consortium leveraging commercial technology for potential application in Army vehicle systems through ongoing and new programs in automotive research, resulting in significant cost savings and performance enhancing technological opportunities. The research performed in this project contributes to formulating and establishing the basic scientific and engineering principles for these technologies.  Work in this project complements and is fully coordinated with work under PE 0602601A (Combat Vehicle and Automotive Technology). Selected university partners include: University of Michigan, Virginia Tech, Wayne State University, University of Iowa, Oakland University, and Clemson University. Key industry partners include all major US automotive manufacturers and suppliers. The Automotive Research Center (ARC) formulates and evaluates advanced automotive technologies and advances state-of-the-art modeling and simulation for the Army's future ground vehicle platforms.  The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering science and technology priority focus areas and the Army Modernization Strategy.  Work in this project is performed by TARDEC, Warren, MI.													
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>									<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>		
<b>Title:</b> Automotive Research Center (ARC)									3.649	4.193	3.157		
<b>Description:</b> Funding is provided for the following effort.													
<b>FY 2013 Accomplishments:</b> Conducted research in areas that included: non-traditional off-road vehicle dynamics and controls, soldier/vehicle interaction modeling, high-performance/lightweight structures and materials, advanced alternative propulsion systems including hybrids,													

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601104A / <i>University and Industry Research Centers</i>	<b>Project (Number/Name)</b> H73 / <i>Automotive Research Center (ARC)</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p>strategic and innovative thermal management schemes, and vehicle system optimization and design for reliability with robustness. Researched targeting key areas such as fuel economy, safety, system compactness, soldier/vehicle performance, cost savings, vehicle control (including autonomous vehicles), and system optimality/reliability.</p> <p><b>FY 2014 Plans:</b> Synthesize and test new hybrid propulsion concepts with novel energy conversion and storage devices; perform engine experiments with combustion modeling to characterize JP-8 performance; design lightweight and safe structures to address impact protection and reliability; integrate physical and cognitive human models to represent driving behavior; classify driver distraction, fatigue and stress; characterize Soft Soil Terra-mechanics and effects on mobility, safety and fuel economy; perform vehicle system integration through verification, validation and certification of vehicle tests, and multi-level vehicle design.</p> <p><b>FY 2015 Plans:</b> Will develop valid predictive simulations tools that integrate design strategies that include reliability, product life management and human/machine interactions. Will improve characterization and representation of human attributes, capabilities, responses, tolerance, and behaviors and employ this knowledge. Will pursue occupant centric vehicle structures that provide safety from explosive threats.</p>			
<b>Accomplishments/Planned Programs Subtotals</b>		3.649	4.193
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			



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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601104A / University and Industry Research Centers				Project (Number/Name) J08 / Institute For Creative Technologies (ICT)			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
J08: Institute For Creative Technologies (ICT)	-	7.134	8.099	7.500	-	7.500	6.125	6.232	6.356	6.490	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
A. Mission Description and Budget Item Justification												
This project supports simulation and training technology research at the Army's Institute for Creative Technologies (ICT) at the University of Southern California. The ICT was established as a University Affiliated Research Center (UARC) to support Army training and readiness through research into simulation and training technology for applications such as mission rehearsal, leadership development, health and medical, and distance learning. The ICT actively performs research and engages industry to exploit dual-use technology and serves as a means for the military to learn about, benefit from, and facilitate the transfer of applicable technologies into military systems. In addition the ICT works with creative talent from the entertainment industry to leverage techniques and capabilities and adapt concepts of story and character to increase the degree of participant immersion in synthetic environments in order to improve the realism and usefulness of these experiences. In developing a true synthesis of the creativity, research, technology, and capability of industry and the research and development community, the ICT is revolutionizing capabilities for the Army by making it more effective in terms of cost, time, range of experiences and the quality of the result. Resulting research, techniques, and technologies and techniques are transitioned for maturation to PE 0602308A/project D02.												
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) in Adelphi, MD.												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2013	FY 2014	FY 2015	
Title: Immersive Environments									2.773	3.111	2.888	
Description: Conduct basic research in immersive environments, to include virtual humans, three dimensional (3-D) sound and visual media, to achieve more efficient and affordable training, modeling, simulation and application solutions and tools. Research includes investigation of techniques and methods to address the rapid development of synthetic environments and the study of perception and cognition to help direct the development of new technologies and techniques that evoke more realistic responses from users.												
FY 2013 Accomplishments: Implemented psychophysiology measures to improve the simulation fidelity of virtual immersive environments; and continued evaluation of techniques and methods to address the rapid development of synthetic environments.												
FY 2014 Plans:												

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601104A / <i>University and Industry Research Centers</i>	<b>Project (Number/Name)</b> J08 / <i>Institute For Creative Technologies (ICT)</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
Investigate integrated augmented reality environments that add virtual elements (people, objects, and events) onto real world visualization for training and learning purposes; and examine techniques for the creation of virtual training content from sources such as mobile devices, mobile sensors, public databases, and sensor networks to make training and distance learning more accessible.  <b>FY 2015 Plans:</b> Will investigate techniques for creating immersive environments and interactions with virtual humans on computing platforms with limited computational resources such as tablet computers and mobile devices; and assess effectiveness of techniques across a variety of contexts (e.g., training, mission rehearsal).			
<b>Title:</b> Graphics and Animations  <b>Description:</b> Research will improve computational techniques in graphics for achieving real-time photo-realistic rendering of physical and synthetic environments for training and simulations. Research into auditory aspects of immersion provides the sound stimulus for increasing the realism for military training and simulation devices.  <b>FY 2013 Accomplishments:</b> Researched the creation of photo-real characters and environments and demonstrate these capabilities; developed comprehensive facial performance capture techniques; developed software for rendering multiple faces; and completed the research investigation of high-fidelity eye models for virtual characters.  <b>FY 2014 Plans:</b> Develop facial animation techniques that accurately mimic human facial expressions; and develop a pipeline which combines automated rigging based on high-fidelity facial scans.  <b>FY 2015 Plans:</b> Will research and develop new methods and algorithms in multi-view optical flow triangulation to align laser-scanned geometry with photographs to reconstruct missed data from previous data capture pipelines.		1.588	1.878
<b>Title:</b> Techniques and Human-Virtual Human Interaction  <b>Description:</b> Conduct basic research to investigate methods and techniques for improving the perception, communication, understanding, and responsiveness of virtual humans when interacting with live humans.  <b>FY 2013 Accomplishments:</b>		2.773	3.110
			2.887

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601104A / <i>University and Industry Research Centers</i>	<b>Project (Number/Name)</b> J08 / <i>Institute For Creative Technologies (ICT)</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
<p>Integrated virtual human system with life-like graphics, facial and body animations and developed multiple forms of learning algorithms as a part of Virtual Humans; and developed group behavior prediction models and algorithms to include social cognition, social perception and social reactivity models and algorithms for virtual humans.</p> <p><b>FY 2014 Plans:</b> Conduct evaluations of the social impact of virtual humans on human users and develop social cues that predict cooperative/ competitive orientation in a bargaining task to expand understanding of effectiveness of virtual characters as role players in training exercises; and implement graphical cognitive architecture into Virtual Humans that will lead to less complex but more human-like systems.</p> <p><b>FY 2015 Plans:</b> Will conduct evaluations and develop theoretical design frameworks to identify the most cost-effective balance between virtual human fidelity and training effectiveness and investigate an individual's response to the human-like behaviors (e.g., persuasion, cultural biases, etc) of virtual role-players; extend virtual human cognitive architecture research to recognize various human behaviors and learn from the agent's past experiences; and investigate the use of linguistics and machine learning for automated knowledge acquisition allowing for the creation of more intelligent and communicative artificial agents.</p>			
<b>Accomplishments/Planned Programs Subtotals</b>		7.134	8.099
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601104A / University and Industry Research Centers				Project (Number/Name) J12 / Institute For Soldier Nanotechnology (ISN)			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
J12: Institute For Soldier Nanotechnology (ISN)	-	9.287	10.553	6.713	-	6.713	6.125	6.232	6.356	6.492	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
Note Not applicable for this item.												
A. Mission Description and Budget Item Justification												
This project supports sustained multidisciplinary research at the Army's Institute for Soldier Nanotechnologies (ISN) at the Massachusetts Institute of Technology. The ISN was established as a University Affiliated Research Center (UARC) to support research to devise nanotechnology-based solutions for the Soldier. The ISN emphasizes revolutionary materials research for advanced Soldier protection and survivability. The ISN works in close collaboration with the U.S. Army Research Laboratory (ARL), the U.S. Army Natick Soldier Research, Development and Engineering Center (NSRDEC), and other U.S. Army Research Development and Engineering Command (RDECOM) elements, as well as several major industrial partners, including Raytheon and DuPont, in pursuit of its goals. This project emphasizes revolutionary materials research toward an advanced uniform concept. The future uniform will integrate a wide range of functionality, including ballistic protection, responsive passive cooling and insulating, screening of chemical and biological agents, biomedical monitoring, performance enhancement, and extremities protection. The objective is to lighten the Soldier's load through system integration and multifunctional devices while increasing survivability. The new technologies will be compatible with other Soldier requirements, including Soldier performance, limited power generation, integrated sensors, communication and display technologies, weapons systems, and expected extremes of temperature, humidity, storage lifetimes, damage, and spoilage.												
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 Lab (ARL) in Adelphi, MD.												
B. Accomplishments/Planned Programs (\$ in Millions)												
Title: Nanomaterials  Description: Nanomaterials research efforts focus on light-weight, multifunctional nanostructured fibers and materials.  FY 2013 Accomplishments: Examined carbon nanotube/conducting polymer composite films assembled onto electrospun nanofibers to determine sensing properties; studied properties conferred by various functional group additions/modifications to polymers for potential sensing									FY 2013	FY 2014	FY 2015	
									2.322	2.639	1.679	

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army			Date: March 2014		
<b>Appropriation/Budget Activity</b> 2040 / 1		<b>R-1 Program Element (Number/Name)</b> PE 0601104A / <i>University and Industry Research Centers</i>		<b>Project (Number/Name)</b> J12 / <i>Institute For Soldier Nanotechnology (ISN)</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>			<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>
applications; investigated the range of electrical robustness of conductive electrospun fibers for future signal communications; and investigated mechanical properties of electrospun materials.					
<b>FY 2014 Plans:</b> Characterize a variety of quantum dot and graphene-based structures as detection elements for night vision applications; perform preliminary characterization of thermal properties at ceramic/polymer interfaces that may provide materials for improved cooling and power generation from waste heat; model hybrid structure architectures of semiconductor materials within pre-drawn fibers to optimize the semiconductor performance within a fiber; and investigate methods for imaging light and sound within arrays of fibers designed for optical and acoustic detection.					
<b>FY 2015 Plans:</b> Will model, synthesize, and study nanoscale objects with tailored composition, size, and geometry that may lead to future applications in obscurant and optical broadband communications; design releasable layer-by-layer, assemblies of stabilized lipid nanocapsules on microneedles that may ultimately enable dynamic monitoring of disease states and enhanced vaccine delivery; model and synthesize nanotube-adsorbed polymer complexes that may provide completely synthetic analogues of antibodies and aptamers capable of detecting and recognizing neurotransmitters and other biologically relevant molecules; and model, synthesize, and characterize scalable and flexible nanoscale patterned metamaterial objects and photonic topological insulators that are able to dynamically respond to electromagnetic fields ranging from optical to microwave wavelengths, potentially providing future materials for integrated sensing or communication elements.					
<b>Title:</b> Blast Effects on Soldier			4.643	5.276	3.356
<b>Description:</b> Blast Effects on Soldier research involves the areas of Battle Suit Medicine and Blast and Ballistic Protection.					
<b>FY 2013 Accomplishments:</b> Investigated natural armor systems to determine related mechanical behavior and penetration resistance; explored how new biological-design concepts can be scaled to resist forces proportional to blast or ballistic impact; assessed new membranes for peptide immobilization and potential as a high-throughput assay of peptide activity; and synthesized and characterized continuous shape memory alloy fibers.					
<b>FY 2014 Plans:</b> Synthesize a library of brain-lipid nanoparticles as a potential encapsulating agent for potential use in targeted therapies to treat traumatic brain injury; measure structure and properties of two-layer aluminum-alloy nanostructures for future design of improved lightweight materials with optimized strength, hardness and toughness; synthesize new protein-based hydrogels as tissue stimulants and test the effects of these hydrogels against blast and ballistic impact; and design and test atomistic level					

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014		
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / University and Industry Research Centers	Project (Number/Name) J12 / Institute For Soldier Nanotechnology (ISN)		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
models for ceramic and polymer systems toward an ultimate multi-scalar model that provides more accurate predictive tools for material failure under blast and ballistic loading conditions.  <b>FY 2015 Plans:</b> Will evaluate and validate advanced large-scale modeling capabilities that may enable high-fidelity, full-scale simulations of the effect of blast and ballistic impact loading on soldier protection systems; computationally probe the physical mechanisms leading to the failure of bone tissue under dynamic compressive loading which may provide predictive models of blast injuries and improve the development of protective foot gear; and objectively define and model the neural correlates of mild traumatic brain injury (mTBI) produced by blast waves which may provide new methods to detect cognitive disorders resulting from mTBI.				
<b>Title:</b> Soldier Protection  <b>Description:</b> Soldier Protection research efforts focused on Soldier Survivability and Protection and Nanosystems Integration.  <b>FY 2013 Accomplishments:</b> Investigated nanotube-based assemblies for detection of DNA and determining whether structures can be adapted to detect other chemicals and biological warfare agents; synthesized and characterized high-quality nanoscale virucidal and bactericidal coatings of sensory polymers using photochemical grafting and other fabrication methods; developed and characterized new fiber designs to determine structures that improve fiber sensing functionality; and functionalized surface of graphene sensing devices to confer different electrochemistries and determine changes in selectivity.  <b>FY 2014 Plans:</b> Investigate modification of a graphene surface toward the design, fabrication and testing of a first-generation graphene sensor optimized for the detection of food pathogens; determine various polymeric structures bound to carbon nanotubes and to screen these complexes against a panel of explosive compounds to potentially enable the future design of a highly-sensitive chemical detection platform; and investigate methods for fabrication and testing of artificial protein polymer hydrogels for potential use as a biodegradable hemostat that can stop blood flow from a wound.  <b>FY 2015 Plans:</b> Will model and synthesize nanocomposite, metamaterial architectures and examine if and how these materials can guide and dissipate energy, potentially providing a method to dissipate blast energy for soldier protection; model, synthesize, and characterize nanostructured protein hydrogels under physiologically relevant conditions which may ultimately lead to a rapid field treatment option for hemorrhagic shock or other trauma; and explore and model the rate-dependent response of biological and synthetic gels to intense loadings over a broad range of length and time scales, which will guide the future design of compliant, protective materials.		2.322	2.638	1.678
Accomplishments/Planned Programs Subtotals		9.287	10.553	6.713

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601104A / <i>University and Industry Research Centers</i>	<b>Project (Number/Name)</b> J12 / <i>Institute For Soldier Nanotechnology (ISN)</i>
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A <b>Remarks</b>  <b>D. Acquisition Strategy</b> N/A  <b>E. Performance Metrics</b> N/A		

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601104A / University and Industry Research Centers				Project (Number/Name) J14 / Army Educational Outreach Program			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
J14: Army Educational Outreach Program	-	8.691	9.733	9.550	-	9.550	9.466	9.608	9.773	9.949	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
Note												
Consolidated funds from PE 0605803/project 729 and PE 06061104/project J14 to align educational outreach program elements into a central funding line of accounting.												
A. Mission Description and Budget Item Justification												
This project supports science activities that encourage elementary/middle/high school and college youths to develop an interest in and pursue higher education and employment in the science, mathematics, and engineering (STEM) fields. These activities are consolidated within the Army Educational Outreach Program (AEOP) that links and networks appropriate components to derive the best synergies to present the Army to a larger pool of technical talent and to provide students with Army-unique practical experiences at Army laboratories, centers, and institutes to fill future Army Science and Technology workforce needs. AEOP increases interest and involvement of students and teachers across the nation in science, mathematics, and engineering at all proficiency levels and backgrounds to include under-represented and economically disadvantaged groups through exposure to Army sponsored research, education, competitions, internships, and practical experiences. This project enhances the national pool of science and engineering personnel that in turn supports defense industry and Army laboratory and research, development, and engineering center needs.												
In FY13, activities and funds for educational outreach were consolidated from PE 0605803/project 729 into PE 0601104/project J14.												
The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering science and technology priority focus area, the Army Modernization Strategy, the Department of Defense STEM Educational Outreach Strategic Plan and the President's "Educate to Innovate" campaign for STEM education.												
Work in this project is performed by the U.S. Army Research, Development, and Engineering Command (RDECOM), the U.S. Army Research Institute (ARI) for the Behavioral and Social Sciences, the U.S. Army Corps of Engineers' Engineer Research and Development Center (ERDC), the U.S. Army Medical Research and Materiel Command (MRMC), the U.S. Army Space and Missile Defense Command (SMDC), and the United States Military Academy (USMA).												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2013	FY 2014	FY 2015	
Title: eCYBERMISSION									3.053	3.887	3.775	
Description: This program supports a nation-wide, web-based, science, technology, engineering and mathematics (STEM) competition for students in grades 6 through 9, designed to stimulate interest and encourage continued education in these areas among middle and high school students nationwide.												



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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014		
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / University and Industry Research Centers	Project (Number/Name) J14 / Army Educational Outreach Program		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
<b>FY 2013 Accomplishments:</b> Continued to increase participation from existing levels with a concentrated effort in underserved populations; increased geographic diversity; sustained eCYBERMISSION; and implemented program enhancements based on lessons learned from previous years.				
<b>FY 2014 Plans:</b> Increase participation from existing levels with a concentrated effort in underserved populations; increase geographic diversity; sustain eCYBERMISSION; and implement program enhancements based on lessons learned from previous years.				
<b>FY 2015 Plans:</b> Will continue STEM activities with a concentrated effort in underserved populations; increase geographic diversity; sustain eCYBERMISSION; and implement program enhancements based on lessons learned from previous years.				
<b>Title:</b> Educational Outreach and Workforce Development		2.416	2.430	2.400
<b>Description:</b> In FY13, funds for this effort transferred from PE 0605803/project 729 to align educational outreach program elements within a single Project.				
<b>FY 2013 Accomplishments:</b> Continued AEOP support to reach under-represented and economically disadvantaged areas to enhance STEM education through student experiences in Army labs and academic partner institutions; and mentored students to broaden their interest in and development of STEM education.				
<b>FY 2014 Plans:</b> Continue AEOP support to reach under-represented and economically disadvantaged areas to enhance STEM education through student experiences in Army labs and academic partner institutions; and mentor students to broaden their interest in and their development of STEM education.				
<b>FY 2015 Plans:</b> Will continue AEOP support to reach under-represented and economically disadvantaged areas to enhance STEM education through student experiences in Army labs and academic partner institutions; and mentor students to broaden their interest in and their development of STEM education.				
<b>Title:</b> Army Educational Outreach Program Cooperative Agreement		2.813	3.073	3.050
<b>Description:</b> The youth science cooperative outreach agreement (COA) encompasses a variety of outreach activities under AEOP. This activity supports a strong partnership with government, academia and industry to address the shortfall of clearable STEM skilled talent preparing for the workforce. These activities include Army-sponsored research, education, competitions,				

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014		
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / University and Industry Research Centers	Project (Number/Name) J14 / Army Educational Outreach Program		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2013	FY 2014	FY 2015
internships and practical experiences designed to engage and guide students and teachers in Army sponsored STEM programs. The funding for this line item was consolidated from PE 0605803/project 729.				
FY 2013 Accomplishments: Continued to increase Army lab and research center sponsorship of students and STEM education opportunities; provided competition incentives in STEM competitions that include scholarships, experiences, and mentorships as well as exposing students to DoD career opportunities; and streamlined processes, leveraged funding and built educational partnerships.				
FY 2014 Plans: Continue Army lab and research center sponsorship of students and STEM education opportunities; provide competition incentives in STEM competitions that include scholarships, experiences and mentorships as well as expose students to DoD career opportunities; streamline processes, leverage funding and build educational partnerships; and perform annual comprehensive review and educational assessments to support future decisions and best practices.				
FY 2015 Plans: Will continue Army lab and research center sponsorship of students and STEM education opportunities; provide competition incentives in STEM competitions that include scholarships, experiences and mentorships as well as expose students to DoD career opportunities; streamline processes, leverage funding and build educational partnerships; and perform annual comprehensive review and educational assessments to support future decisions and best practices.				
Title: West Point Cadet Research		0.409	0.343	0.325
Description: In FY13, funds for this effort transferred from PE 0605803/project 729 to align educational outreach program elements within a single Project.				
FY 2013 Accomplishments: Conducted West Point cadet research internship programs to enhance cadet training through field experience within Army research labs and centers.				
FY 2014 Plans: Conduct West Point cadet research internship program to enhance cadet training through field experience within Army research labs and centers.				
FY 2015 Plans: Will conduct West Point cadet research internship program to enhance cadet training through field experience within Army research labs and centers.				
Accomplishments/Planned Programs Subtotals		8.691	9.733	9.550

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / <i>University and Industry Research Centers</i>	Project (Number/Name) J14 / <i>Army Educational Outreach Program</i>
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A		
<b>Remarks</b>		
<b>D. Acquisition Strategy</b> N/A		
<b>E. Performance Metrics</b> N/A		

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601104A / University and Industry Research Centers				Project (Number/Name) J15 / Network Sciences ITA			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
J15: Network Sciences ITA	-	3.912	4.122	3.861	-	3.861	4.275	4.339	4.414	4.493	-	-

# The FY 2015 OCO Request will be submitted at a later date.

Note

Not applicable for this item.

A. Mission Description and Budget Item Justification

This project supports research at a competitively selected United States (U.S.)/United Kingdom (U.K.) government, university, and industry consortium established to perform fundamental network and information science investigations in the areas of network theory, system-of-systems security, sensor processing and delivery, and distributed coalition planning and decision making. The focus is on enhancing distributed, secure, and flexible decision-making to improve coalition operations, and developing the scientific foundations for complex and dynamic networked systems-of-systems to support the complex human, social, and technical interactions anticipated in future coalition operations with the emphasis on integration of multiple technical disciplines in an international arena. The U.S. Army Research Laboratory (ARL) and the U.K. Ministry of Defense (MOD) established the jointly funded and managed U.S. and U.K. consortium, known as the International Technology Alliance (ITA) on Network and Information Sciences, in FY06.

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) at Adelphi, MD.

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

	FY 2013	FY 2014	FY 2015
<b>Title:</b> Network and Information Science Basic Research for U.S./U.K. Coalition Operations Information	3.912	4.122	3.861
<b>Description:</b> This research will address the fundamental science underpinning the complex information network issues that are vital to future U.S./U.K. coalition military operations and to fully exploit the joint development of emerging technologies necessary to enable coalition operations.			
<b>FY 2013 Accomplishments:</b> Developed scaling laws for hybrid networks with less restrictive assumptions regarding network homogeneity (relax the assumptions to account for variable bandwidth, network management information, etc.); and developed techniques for the management and control of hybrid coalition networks and techniques for the security of distributed services. These efforts			

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601104A / <i>University and Industry Research Centers</i>	<b>Project (Number/Name)</b> J15 / <i>Network Sciences ITA</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
contribute to the creation of novel capabilities to assist coalition Warfighters' capability to manage secure distribution of information in coalition networks, with efficiency and agility.  <b>FY 2014 Plans:</b> Develop controlled natural language that enables information extraction from structured and unstructured data sources to improve interactions between analyst and machine processing; develop techniques to enable dynamic group coalition information exchange in hybrid mobile ad hoc and cellular networks; and develop efficient and secure access to distributed data as a service among coalition partners without disclosure of security policies. These efforts enhance network security and information sharing in coalition operations.  <b>FY 2015 Plans:</b> Will develop integrated analysis algorithms of data derived from hybrid networks to aid analysts in performing projective analysis; develop techniques to provide risk averse and security conscious analysis capabilities to distributed mobile devices among coalition partners; and develop secure energy-aware and resource-aware access to distributed computing resources. These efforts will enhance network and security analysis while improving the effective use of coalition resources available to the Warfighter.			
<b>Accomplishments/Planned Programs Subtotals</b>		3.912	4.122
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b>			
N/A			
<b>E. Performance Metrics</b>			
N/A			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601104A / University and Industry Research Centers				Project (Number/Name) J17 / Vertical Lift Research Center Of Excellence			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
J17: Vertical Lift Research Center Of Excellence	-	2.473	3.061	2.885	-	2.885	3.053	3.099	3.153	3.210	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
Note Not applicable for this item.												
A. Mission Description and Budget Item Justification												
This project fosters research to provide vertical lift capability and engineering expertise for the Army. The focus of the Vertical Lift Research Center of Excellence is to couple state-of-the-art research programs with broad-based graduate education programs at academic institutions with the goal of increasing the supply of scientists and engineers who can contribute to Army Transformation. Work will provide research into technologies that can improve tactical mobility, reduce the logistics footprint, and increase survivability for rotary wing vehicles.												
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 extramurally by the Aeroflightdynamics Directorate of the Aviation and Missile Research, Development, and Engineering Center (AMRDEC) (located at the NASA Ames Research Center, Moffett Field, CA).												
B. Accomplishments/Planned Programs (\$ in Millions)									FY 2013	FY 2014	FY 2015	
Title: Vertical Lift Research Center of Excellence									2.473	3.061	2.885	
Description: Began year two of new VLRCOE agreements with Penn State University, University of Maryland, and Georgia Institute of Technology; secured Navy and NASA funding to supplement a robust experimental and analytic basic research program in rotorcraft technologies including: Aeromechanics, Structures, Flight Dynamics and Control, Rotorcraft Design and Concepts, Vibration and Noise Control, Propulsion, Affordability, Safety and Survivability, and Naval Operations.												
FY 2013 Accomplishments: Implement year two of new VLRCOE agreements with Penn State University, University of Maryland, and Georgia Institute of Technology; secure Navy and NASA funding to supplement a robust experimental and analytic basic research program in rotorcraft technologies including: Aeromechanics, Structures, Flight Dynamics and Control, Rotorcraft Design and Concepts, Vibration and Noise Control, Propulsion, Affordability, Safety and Survivability, and Naval Operations.												
FY 2014 Plans:												

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014		
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601104A / <i>University and Industry Research Centers</i>	<b>Project (Number/Name)</b> J17 / <i>Vertical Lift Research Center Of Excellence</i>		
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b> Implement year three of VLRCOE agreements with Penn State University, University of Maryland, and Georgia Institute of Technology to conduct a robust experimental and analytic basic research program in rotorcraft technologies including: Aeromechanics, Structures, Flight Dynamics and Control, Rotorcraft Design and Concepts, Vibration and Noise Control, Propulsion, Affordability, Safety and Survivability, and Naval Operations  <b>FY 2015 Plans:</b> Will implement year four of VLRCOE agreements with Penn State University, University of Maryland, and Georgia Institute of Technology to conduct a robust experimental and analytic basic research program in rotorcraft technologies including: Aeromechanics, Structures, Flight Dynamics and Control, Rotorcraft Design and Concepts, Vibration and Noise Control, Propulsion, Affordability, Safety and Survivability, and Naval Operations.		<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>
<b>Accomplishments/Planned Programs Subtotals</b>		2.473	3.061	2.885
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A  <b>Remarks</b>  <b>D. Acquisition Strategy</b> N/A  <b>E. Performance Metrics</b> N/A				

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601104A / University and Industry Research Centers				Project (Number/Name) VS2 / Multi-Scale Materials Modeling Centers			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
VS2: Multi-Scale Materials Modeling Centers	-	7.700	8.609	9.639	-	9.639	9.364	9.504	9.668	9.842	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
Note Not applicable for this item.												
A. Mission Description and Budget Item Justification												
This project supports two competitively awarded Collaborative Research Alliances (CRAs) to provide the Army with next generation multi-functional materials for ballistic and electronic applications and to address the extreme challenges associated with understanding and modeling materials subject to Army operational environments. The Materials in Extreme Dynamic Environments consortium, led by Johns Hopkins University partnered with CalTech, Rutgers University, and University of Delaware, focuses on understanding materials under high strain-rates. The Multiscale/Multidisciplinary Modeling of Electronic Materials consortium, led by University of Utah partnered with Boston University, and Rensselaer Polytechnic Institute, focuses on microscale properties to design macroscale behavior for electronics. Research at both CRAs will address the modeling and experimental challenges associated with developing multidisciplinary physics simulations across multiple length scales for materials to include: a limited ability to relate materials chemistry, structure, and defects to materials response and failure under extreme conditions; an inadequate ability to predict the roles of materials structure, processing, and properties on performance in relevant extreme environments and designs; and the lack of experimental capabilities to quantify multiscale response and failure of materials under extreme conditions.												
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) in Aberdeen Proving Ground, MD.												
B. Accomplishments/Planned Programs (\$ in Millions)												
Title: Collaborative Research Alliances in Materials in Extreme Dynamic Environments and Multiscale Multidisciplinary Modeling of Electronic Materials.  Description: Research will focus on the following areas: two-way multiscale modeling for predicting performance and designing materials, investigating analytical and theoretical analyses to effectively define the interface physics across length scales; advancing experimental capabilities for verification and validation of multiscale physics; and modeling and strategies for the synthesis of high loading rate tolerant materials so that all of the latter lead to the development of a comprehensive set of metrics that define high loading rate tolerant material systems. The multi-scale modeling capability will be applied across multiple									FY 2013	FY 2014	FY 2015	
									7.700	8.609	9.639	



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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601104A / <i>University and Industry Research Centers</i>	<b>Project (Number/Name)</b> VS2 / <i>Multi-Scale Materials Modeling Centers</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
disciplines to facilitate revolutionary advances in materials for coupled environments (electromagnetic, high rate, high pressure and other extreme environments).			
<p><b><i>FY 2013 Accomplishments:</i></b>            Demonstrated real-time microstructural interrogation of materials during high-rate experiments; identified key microstructural phenomena related to high-rate deformation, fracture, and failure at critical length and time scales; and accurately predicted bulk dynamic properties based upon models built up from smaller size scales in each of the four selected material systems (metallic, polymeric, ceramic, and composite).</p> <p><b><i>FY 2014 Plans:</i></b>            Model and characterize metallic, polymeric, ceramic and composite material systems response to extreme dynamic environments to enhance the fidelity of simulation codes that optimize hybrid multi-material protection for soldier and vehicle systems; implement physics-based modeling of electronic materials by developing a set of multiscale algorithms/theories that enable better understanding of material, electronic, optical and opto-electronic properties; and develop multiscale models and algorithms that predict the bulk and interfacial properties of fuel cells and electrochemical energy sources. Resulting models and algorithms enable the advancement of the next generation sensors and power and energy devices on the battlefield.</p> <p><b><i>FY 2015 Plans:</i></b>            Will conduct research to achieve a comprehensive "materials-by-design" capability to include designing materials and predicting key properties for materials in extreme dynamic environments through the integration of novel experimental methodologies and multiscale computational approaches; validate material characteristics and properties at length scales that govern high rate deformation, fracture and failure phenomena in metallic, polymeric, ceramic and composite material systems through both computational and experimental techniques; research fabrication technology for optimized polymeric, metallic, ceramic and composite systems; and investigate interface physics (with regards to strain, polarization, piezoelectric, electromagnetic phenomena and solid/liquid boundaries). Results will advance the state-of-the art in multiscale modeling for electronic materials to create a capability for "materials optimization" and "materials by design" supporting increased efficiency, source and detector lifetimes, increased power density (in electrochemical energy storage devices), and advancing the understanding of electronic materials to include interactions of electrons, photons, phonons, defects and impurities.</p>			
<b>Accomplishments/Planned Programs Subtotals</b>		7.700	8.609
<b>C. Other Program Funding Summary (\$ in Millions)</b>			
N/A			
<b>Remarks</b>			

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army		Date: March 2014
Appropriation/Budget Activity 2040 / 1	R-1 Program Element (Number/Name) PE 0601104A / <i>University and Industry Research Centers</i>	Project (Number/Name) VS2 / <i>Multi-Scale Materials Modeling Centers</i>
D. Acquisition Strategy N/A		
E. Performance Metrics N/A		

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Exhibit R-2A, RDT&E Project Justification: PB 2015 Army										Date: March 2014		
Appropriation/Budget Activity 2040 / 1					R-1 Program Element (Number/Name) PE 0601104A / University and Industry Research Centers				Project (Number/Name) VS3 / Center For Quantum Science Research			
COST (\$ in Millions)	Prior Years	FY 2013	FY 2014	FY 2015 Base	FY 2015 OCO #	FY 2015 Total	FY 2016	FY 2017	FY 2018	FY 2019	Cost To Complete	Total Cost
VS3: Center For Quantum Science Research	-	-	-	5.000	-	5.000	5.221	5.240	5.261	7.284	-	-
# The FY 2015 OCO Request will be submitted at a later date.												
<b>Note</b> no funding for this program in FY14												
<b>A. Mission Description and Budget Item Justification</b> No funding for this program in FY14  This project supports two extramural research consortiums, each of which will bring together a critical mass of preeminent university researchers to explore and develop critical emerging concepts in Quantum Information Science (QIS). Focus will be on two areas of QIS that are expected to provide disruptive impacts on Army warfighter capabilities, and to perform collaborative research with Army in-house scientists and engineers to help accelerate the transition of the research. One focus area will be on quantum simulations to provide previously unattainable capabilities to model and design high-performance materials crucial for the individual soldier and Army equipment. The other focus area is in precision measurement using quantum sensing and imaging to provide leap-ahead imaging capabilities that would have been considered impossible using classical physics and current state of the art engineering. In addition to providing the required focused level of effort, the consortiums will also provide the broad unified multidisciplinary effort the field of QIS needs to accelerate progress, ranging from pure mathematics to engineering.  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) in Adelphi, MD.												
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>									<b>FY 2013</b>	<b>FY 2014</b>	<b>FY 2015</b>	
<b>Title:</b> Center for the Exploitation of Quantum Effects									-	-	5.000	
<b>Description:</b> This program supports critical quantum science basic research at the Army Research Laboratory exploiting quantum effects to greatly enhance computing, communication, imaging, sensing and security ensuring Army dominance on the future battlefield.												
<b>FY 2015 Plans:</b> Will research mapping between model quantum systems and the system whose properties need to be understood and controlled using atoms in optical lattices, ions in radio frequency (RF) traps, atoms in cavities with and without mechanical resonators,												

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<b>Exhibit R-2A, RDT&amp;E Project Justification:</b> PB 2015 Army		<b>Date:</b> March 2014	
<b>Appropriation/Budget Activity</b> 2040 / 1	<b>R-1 Program Element (Number/Name)</b> PE 0601104A / <i>University and Industry Research Centers</i>	<b>Project (Number/Name)</b> VS3 / <i>Center For Quantum Science Research</i>	
<b>B. Accomplishments/Planned Programs (\$ in Millions)</b>		<b>FY 2013</b>	<b>FY 2014</b>
and other approaches; and conduct research to elucidate the role and creation of quantum resources such as superposition, entanglement, and entanglement swapping (including long-range and long-time as needed for quantum repeaters), in overcoming the limitations of classical systems.			
<b>Accomplishments/Planned Programs Subtotals</b>		-	5.000
<b>C. Other Program Funding Summary (\$ in Millions)</b> N/A			
<b>Remarks</b>			
<b>D. Acquisition Strategy</b> N/A			
<b>E. Performance Metrics</b> N/A			