Department of Defense
Fiscal Year (FY) 2019 Budget Estimates

February 2018

Army

Justification Book of

Research, Development, Test & Evaluation, Army

RDT&E − Volume I, Budget Activity 2

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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, $10,484,483,000.00 to remain available for obligation until September 30, 2020.

The following Justification Books were prepared at a cost of $226,413: 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.

Department of Defense
FY 2019 President's Budget
Exhibit R-1 FY 2019 President's Budget
Total Obligational Authority
(Dollars in Thousands)

18 Jan 2018

Appropriation	FY 2017 (Base + OCO)	FY 2018 PB Request with CR Adj Base	FY 2018 Total PB Requests* with CR Adj Base	FY 2018 PB Request with CR Adj OCO	FY 2018 Total PB Requests+ with CR Adj OCO
Research, Development, Test & Eval, Army	8,852,507	8,273,447	8,273,447	342,356	342,356
Total Research, Development, Test & Evaluation	8,852,507	8,273,447	8,273,447	342,356	342,356

R-119PB: FY 2019 President's Budget (Published Version), as of January 18, 2018 at 15:06:20

Department of Defense
FY 2019 President's Budget
Exhibit R-1 FY 2019 President's Budget
Total Obligational Authority
(Dollars in Thousands)

18 Jan 2018

Appropriation	FY 2018 Emergency Requests** Emergency	FY 2018 Less Enacted Div B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req Emergency	FY 2018 Total PB Requests* with CR Adj Base + OCO + Emergency**	FY 2018 Less Enacted DIV B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req with CR Adj Base + OCO + Emergency
Research, Development, Test & Eval, Army	20,700	-20,700		8,636,503	-20,700	8,615,803
Total Research, Development, Test & Evaluation	20,700	-20,700		8,636,503	-20,700	8,615,803

Department of Defense
FY 2019 President's Budget
Exhibit R-1 FY 2019 President's Budget
Total Obligational Authority
(Dollars in Thousands)

18 Jan 2018

Appropriation	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Research, Development, Test & Eval, Army	10,159,379	325,104	10,484,483
Total Research, Development, Test & Evaluation	10,159,379	325,104	10,484,483

Department of Defense
FY 2019 President's Budget
Exhibit R-1 FY 2019 President's Budget
Total Obligational Authority
(Dollars in Thousands)

18 Jan 2018

Summary Recap of Budget Activities	FY 2017 (Base + OCO)	FY 2018 PB Request with CR Adj Base	FY 2018 Total PB Requests* with CR Adj Base	FY 2018 PB Request with CR Adj OCO	FY 2018 Total PB Requests+ with CR Adj OCO
Basic Research	473,216	430,022	430,022		
Applied Research	1,196,132	889,182	889,182		
Advanced Technology Development	1,351,035	1,070,977	1,070,977		
Advanced Component Development & Prototypes	619,976	890,889	890,889	18,000	18,000
System Development & Demonstration	2,502,560	3,012,840	3,012,840	57,840	57,840
RDT&E Management Support	1,413,481	1,253,845	1,253,845		
Operational Systems Development	1,296,107	1,877,685	1,877,685	43,528	43,528
Undistributed		-1,151,993	-1,151,993	222,988	222,988
Total Research, Development, Test & Evaluation	8,852,507	8,273,447	8,273,447	342,356	342,356
Summary Recap of FYDP Programs					
General Purpose Forces	611,072	710,401	710,401	15,000	15,000
Intelligence and Communications	342,648	370,519	370,519	29,728	29,728
Research and Development	7,826,372	8,215,942	8,215,942	74,640	74,640
Central Supply and Maintenance	59,891	60,877	60,877		
Administration and Associated Activities	7,899	-1,151,993	-1,151,993	222,988	222,988
Space		60,547	60,547		
Classified Programs	4,625	7,154	7,154		
Total Research, Development, Test & Evaluation	8,852,507	8,273,447	8,273,447	342,356	342,356

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Department of Defense
FY 2019 President's Budget
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Total Obligational Authority
(Dollars in Thousands)

18 Jan 2018

Summary Recap of Budget Activities	FY 2018 Emergency Requests** Emergency	FY 2018 Less Enacted Div B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req Emergency	FY 2018 Total PB Requests* with CR Adj Base + OCO + Emergency**	FY 2018 Less Enacted DIV B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req with CR Adj Base + OCO + Emergency
Basic Research				430,022		430,022
Applied Research				889,182		889,182
Advanced Technology Development	12,000	-12,000		1,082,977	-12,000	1,070,977
Advanced Component Development & Prototypes	8,700	-8,700		917,589	-8,700	908,889
System Development & Demonstration				3,070,680		3,070,680
RDT&E Management Support				1,253,845		1,253,845
Operational Systems Development				1,921,213		1,921,213
Undistributed				-929,005		-929,005
Total Research, Development, Test & Evaluation	20,700	-20,700		8,636,503	-20,700	8,615,803
Summary Recap of FYDP Programs						
General Purpose Forces				725,401		725,401
Intelligence and Communications				400,247		400,247
Research and Development	20,700	-20,700		8,311,282	-20,700	8,290,582
Central Supply and Maintenance				60,877		60,877
Administration and Associated Activities				-929,005		-929,005
Space				60,547		60,547
Classified Programs				7,154		7,154
Total Research, Development, Test & Evaluation	20,700	-20,700		8,636,503	-20,700	8,615,803

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Department of Defense
FY 2019 President's Budget
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Total Obligational Authority
(Dollars in Thousands)

18 Jan 2018

Summary Recap of Budget Activities	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Basic Research	445,895		445,895
Applied Research	919,609		919,609
Advanced Technology Development	1,026,698		1,026,698
Advanced Component Development & Prototypes	1,329,393	28,500	1,357,893
System Development & Demonstration	3,192,689	236,863	3,429,552
RDT&E Management Support	1,322,481		1,322,481
Operational Systems Development	1,922,614	59,741	1,982,355
Undistributed			
Total Research, Development, Test & Evaluation	10,159,379	325,104	10,484,483

Summary Recap of FYDP Programs			
General Purpose Forces	783,464	10,000	793,464
Intelligence and Communications	313,112	40,613	353,725
Research and Development	8,775,582	274,491	9,050,073
Central Supply and Maintenance	53,958		53,958
Administration and Associated Activities			
Space	227,308		227,308
Classified Programs	5,955		5,955
Total Research, Development, Test & Evaluation	10,159,379	325,104	10,484,483

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Department of the Army
FY 2019 President's Budget
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18 Jan 2018

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Basic Research	473,216	430,022	430,022		
Applied Research	1,196,132	889,182	889,182		
Advanced Technology Development	1,351,035	1,070,977	1,070,977		
Advanced Component Development & Prototypes	619,976	890,889	890,889	18,000	18,000
System Development & Demonstration	2,502,560	3,012,840	3,012,840	57,840	57,840
RDT&E Management Support	1,413,481	1,253,845	1,253,845		
Operational Systems Development	1,296,107	1,877,685	1,877,685	43,528	43,528
Undistributed		-1,151,993	-1,151,993	222,988	222,988
Total Research, Development, Test & Evaluation	8,852,507	8,273,447	8,273,447	342,356	342,356

Summary Recap of FYDP Programs					
General Purpose Forces	611,072	710,401	710,401	15,000	15,000
Intelligence and Communications	342,648	370,519	370,519	29,728	29,728
Research and Development	7,826,372	8,215,942	8,215,942	74,640	74,640
Central Supply and Maintenance	59,891	60,877	60,877		
Administration and Associated Activities	7,899	-1,151,993	-1,151,993	222,988	222,988
Space		60,547	60,547		
Classified Programs	4,625	7,154	7,154		
Total Research, Development, Test & Evaluation	8,852,507	8,273,447	8,273,447	342,356	342,356

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Advanced Technology Development	12,000	-12,000		1,082,977	-12,000	1,070,977
Advanced Component Development & Prototypes	8,700	-8,700		917,589	-8,700	908,889
System Development & Demonstration				3,070,680		3,070,680
RDT&E Management Support				1,253,845		1,253,845
Operational Systems Development				1,921,213		1,921,213
Undistributed				-929,005		-929,005
Total Research, Development, Test & Evaluation	20,700	-20,700		8,636,503	-20,700	8,615,803
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General Purpose Forces				725,401		725,401
Intelligence and Communications				400,247		400,247
Research and Development	20,700	-20,700		8,311,282	-20,700	8,290,582
Central Supply and Maintenance				60,877		60,877
Administration and Associated Activities				-929,005		-929,005
Space				60,547		60,547
Classified Programs				7,154		7,154
Total Research, Development, Test & Evaluation	20,700	-20,700		8,636,503	-20,700	8,615,803

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Central Supply and Maintenance	53,958		53,958
Administration and Associated Activities			
Space	227,308		227,308
Classified Programs	5,955		5,955
Total Research, Development, Test & Evaluation	10,159,379	325,104	10,484,483

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Department of the Army
FY 2019 President's Budget
Exhibit R-1 FY 2019 President's Budget
Total Obligational Authority
(Dollars in Thousands)

18 Jan 2018

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

Line No	Program Element Number	Item	Act	FY 2017 (Base + OCO)	FY 2018 PB Request with CR Adj Base	FY 2018 Total PB Requests* with CR Adj Base	FY 2018 PB Request with CR Adj OCO	FY 2018 Total PB Requests+ with CR Adj OCO	Sec
1	0601101A	In-House Laboratory Independent Research	01	11,936	12,010	12,010			U
2	0601102A	Defense Research Sciences	01	286,086	263,590	263,590			U
3	0601103A	University Research Initiatives	01	66,506	67,027	67,027			U
4	0601104A	University and Industry Research Centers	01	108,688	87,395	87,395			U
	Basic Research			473,216	430,022	430,022			
5	0602105A	Materials Technology	02	81,950	29,640	29,640			U
6	0602120A	Sensors and Electronic Survivability	02	50,574	35,730	35,730			U
7	0602122A	TRACTOR HIP	02	6,995	8,627	8,627			U
8	0602126A	TRACTOR JACK	02						U
9	0602211A	Aviation Technology	02	67,593	66,086	66,086			U
10	0602270A	Electronic Warfare Technology	02	34,528	27,144	27,144			U
11	0602303A	Missile Technology	02	66,173	43,742	43,742			U
12	0602307A	Advanced Weapons Technology	02	52,766	22,785	22,785			U
13	0602308A	Advanced Concepts and Simulation	02	29,767	28,650	28,650			U
14	0602601A	Combat Vehicle and Automotive Technology	02	89,852	67,232	67,232			U
15	0602618A	Ballistics Technology	02	103,484	85,309	85,309			U
16	0602622A	Chemical, Smoke and Equipment Defeating Technology	02	3,772	4,004	4,004			U
17	0602623A	Joint Service Small Arms Program	02	5,331	5,615	5,615			U

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

18 Jan 2018

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

Line No	Program Element Number	Item	Act	FY 2018 Emergency Requests** Emergency	FY 2018 Less Enacted Div B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req Emergency	FY 2018 Total PB Requests* with CR Adj Base + OCO + Emergency**	FY 2018 Less Enacted DIV B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req with CR Adj Base + OCO + Emergency	Sec
1	0601101A	In-House Laboratory Independent Research	01				12,010		12,010	U
2	0601102A	Defense Research Sciences	01				263,590		263,590	U
3	0601103A	University Research Initiatives	01				67,027		67,027	U
4	0601104A	University and Industry Research Centers	01				87,395		87,395	U
		Basic Research					430,022		430,022	
5	0602105A	Materials Technology	02				29,640		29,640	U
6	0602120A	Sensors and Electronic Survivability	02				35,730		35,730	U
7	0602122A	TRACTOR HIP	02				8,627		8,627	U
8	0602126A	TRACTOR JACK	02							U
9	0602211A	Aviation Technology	02				66,086		66,086	U
10	0602270A	Electronic Warfare Technology	02				27,144		27,144	U
11	0602303A	Missile Technology	02				43,742		43,742	U
12	0602307A	Advanced Weapons Technology	02				22,785		22,785	U
13	0602308A	Advanced Concepts and Simulation	02				28,650		28,650	U
14	0602601A	Combat Vehicle and Automotive Technology	02				67,232		67,232	U
15	0602618A	Ballistics Technology	02				85,309		85,309	U
16	0602622A	Chemical, Smoke and Equipment Defeating Technology	02				4,004		4,004	U
17	0602623A	Joint Service Small Arms Program	02				5,615		5,615	U

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18 Jan 2018

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

Line No	Program Element Number	Item	Act	FY 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
1	0601101A	In-House Laboratory Independent Research	01	11,585		11,585	U
2	0601102A	Defense Research Sciences	01	276,912		276,912	U
3	0601103A	University Research Initiatives	01	65,283		65,283	U
4	0601104A	University and Industry Research Centers	01	92,115		92,115	U
	Basic Research			445,895		445,895	
5	0602105A	Materials Technology	02	28,600		28,600	U
6	0602120A	Sensors and Electronic Survivability	02	32,366		32,366	U
7	0602122A	TRACTOR HIP	02	8,674		8,674	U
8	0602126A	TRACTOR JACK	02	400		400	U
9	0602211A	Aviation Technology	02	64,847		64,847	U
10	0602270A	Electronic Warfare Technology	02	25,571		25,571	U
11	0602303A	Missile Technology	02	50,183		50,183	U
12	0602307A	Advanced Weapons Technology	02	29,502		29,502	U
13	0602308A	Advanced Concepts and Simulation	02	28,500		28,500	U
14	0602601A	Combat Vehicle and Automotive Technology	02	70,450		70,450	U
15	0602618A	Ballistics Technology	02	75,541		75,541	U
16	0602622A	Chemical, Smoke and Equipment Defeating Technology	02	5,032		5,032	U
17	0602623A	Joint Service Small Arms Program	02	12,394		12,394	U

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Line No	Program Element Number	Item	Act	FY 2017 (Base + OCO)	FY 2018 PB Request with CR Adj Base	FY 2018 Total PB Requests* with CR Adj Base	FY 2018 PB Request with CR Adj OCO	FY 2018 Total PB Requests+ with CR Adj OCO	Sec
18	0602624A	Weapons and Munitions Technology	02	118,068	41,455	41,455			U
19	0602705A	Electronics and Electronic Devices	02	72,979	58,352	58,352			U
20	0602709A	Night Vision Technology	02	34,762	34,723	34,723			U
21	0602712A	Countermine Systems	02	29,495	26,190	26,190			U
22	0602716A	Human Factors Engineering Technology	02	23,359	24,127	24,127			U
23	0602720A	Environmental Quality Technology	02	21,553	21,678	21,678			U
24	0602782A	Command, Control, Communications Technology	02	36,396	33,123	33,123			U
25	0602783A	Computer and Software Technology	02	13,452	14,041	14,041			U
26	0602784A	Military Engineering Technology	02	92,140	67,720	67,720			U
27	0602785A	Manpower/Personnel/Training Technology	02	23,475	20,216	20,216			U
28	0602786A	Warfighter Technology	02	59,327	39,559	39,559			U
29	0602787A	Medical Technology	02	78,341	83,434	83,434			U
		Applied Research		1,196,132	889,182	889,182			
30	0603001A	Warfighter Advanced Technology	03	50,004	44,863	44,863			U
31	0603002A	Medical Advanced Technology	03	106,040	67,780	67,780			U
32	0603003A	Aviation Advanced Technology	03	111,654	160,746	160,746			U
33	0603004A	Weapons and Munitions Advanced Technology	03	198,245	84,079	84,079			U
34	0603005A	Combat Vehicle and Automotive Advanced Technology	03	163,501	125,537	125,537			U

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18 Jan 2018

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Line No	Program Element Number	Item	Act	FY 2018 Emergency Requests** Emergency	FY 2018 Less Enacted Div B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req Emergency	FY 2018 Total PB Requests* with CR Adj Base + OCO + Emergency**	FY 2018 Less Enacted DIV B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req with CR Adj Base + OCO + Emergency	Sec
18	0602624A	Weapons and Munitions Technology	02				41,455		41,455	U
19	0602705A	Electronics and Electronic Devices	02				58,352		58,352	U
20	0602709A	Night Vision Technology	02				34,723		34,723	U
21	0602712A	Countermine Systems	02				26,190		26,190	U
22	0602716A	Human Factors Engineering Technology	02				24,127		24,127	U
23	0602720A	Environmental Quality Technology	02				21,678		21,678	U
24	0602782A	Command, Control, Communications Technology	02				33,123		33,123	U
25	0602783A	Computer and Software Technology	02				14,041		14,041	U
26	0602784A	Military Engineering Technology	02				67,720		67,720	U
27	0602785A	Manpower/Personnel/Training Technology	02				20,216		20,216	U
28	0602786A	Warfighter Technology	02				39,559		39,559	U
29	0602787A	Medical Technology	02				83,434		83,434	U
		Applied Research					889,182		889,182	
30	0603001A	Warfighter Advanced Technology	03				44,863		44,863	U
31	0603002A	Medical Advanced Technology	03				67,780		67,780	U
32	0603003A	Aviation Advanced Technology	03				160,746		160,746	U
33	0603004A	Weapons and Munitions Advanced Technology	03				84,079		84,079	U
34	0603005A	Combat Vehicle and Automotive Advanced Technology	03				125,537		125,537	U

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Line No	Program Element Number	Item	Act	FY 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
18	0602624A	Weapons and Munitions Technology	02	40,444		40,444	U
19	0602705A	Electronics and Electronic Devices	02	58,283		58,283	U
20	0602709A	Night Vision Technology	02	29,582		29,582	U
21	0602712A	Countermine Systems	02	21,244		21,244	U
22	0602716A	Human Factors Engineering Technology	02	24,131		24,131	U
23	0602720A	Environmental Quality Technology	02	13,242		13,242	U
24	0602782A	Command, Control, Communications Technology	02	55,003		55,003	U
25	0602783A	Computer and Software Technology	02	14,958		14,958	U
26	0602784A	Military Engineering Technology	02	78,159		78,159	U
27	0602785A	Manpower/Personnel/Training Technology	02	21,862		21,862	U
28	0602786A	Warfighter Technology	02	40,566		40,566	U
29	0602787A	Medical Technology	02	90,075		90,075	U
		Applied Research		919,609		919,609	
30	0603001A	Warfighter Advanced Technology	03	39,338		39,338	U
31	0603002A	Medical Advanced Technology	03	62,496		62,496	U
32	0603003A	Aviation Advanced Technology	03	124,958		124,958	U
33	0603004A	Weapons and Munitions Advanced Technology	03	102,686		102,686	U
34	0603005A	Combat Vehicle and Automotive Advanced Technology	03	119,739		119,739	U

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

Line No	Program Element Number	Item	Act	FY 2017 (Base + OCO)	FY 2018 PB Request with CR Adj Base	FY 2018 Total PB Requests* with CR Adj Base	FY 2018 PB Request with CR Adj OCO	FY 2018 Total PB Requests+ with CR Adj OCO	Sec
35	0603006A	Space Application Advanced Technology	03	3,787	12,231	12,231			U
36	0603007A	Manpower, Personnel and Training Advanced Technology	03	12,110	6,466	6,466			U
37	0603009A	TRACTOR HIKE	03	21,374	28,552	28,552			U
38	0603015A	Next Generation Training & Simulation Systems	03	18,238	16,434	16,434			U
39	0603020A	TRACTOR ROSE	03	11,910					U
40	0603125A	Combating Terrorism - Technology Development	03	33,553	26,903	26,903			U
41	0603130A	TRACTOR NAIL	03	2,340	4,880	4,880			U
42	0603131A	TRACTOR EGGS	03	2,470	4,326	4,326			U
43	0603270A	Electronic Warfare Technology	03	40,819	31,296	31,296			U
44	0603313A	Missile and Rocket Advanced Technology	03	113,683	62,850	62,850			U
45	0603322A	TRACTOR CAGE	03	11,107	12,323	12,323			U
46	0603461A	High Performance Computing Modernization Program	03	215,462	182,331	182,331			U
47	0603606A	Landmine Warfare and Barrier Advanced Technology	03	16,798	17,948	17,948			U
48	0603607A	Joint Service Small Arms Program	03	5,615	5,796	5,796			U
49	0603710A	Night Vision Advanced Technology	03	42,798	47,135	47,135			U
50	0603728A	Environmental Quality Technology Demonstrations	03	21,415	10,421	10,421			U

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35	0603006A	Space Application Advanced Technology	03				12,231		12,231	U
36	0603007A	Manpower, Personnel and Training Advanced Technology	03				6,466		6,466	U
37	0603009A	TRACTOR HIKE	03	12,000	-12,000		40,552	-12,000	28,552	U
38	0603015A	Next Generation Training & Simulation Systems	03				16,434		16,434	U
39	0603020A	TRACTOR ROSE	03							U
40	0603125A	Combating Terrorism - Technology Development	03				26,903		26,903	U
41	0603130A	TRACTOR NAIL	03				4,880		4,880	U
42	0603131A	TRACTOR EGGS	03				4,326		4,326	U
43	0603270A	Electronic Warfare Technology	03				31,296		31,296	U
44	0603313A	Missile and Rocket Advanced Technology	03				62,850		62,850	U
45	0603322A	TRACTOR CAGE	03				12,323		12,323	U
46	0603461A	High Performance Computing Modernization Program	03				182,331		182,331	U
47	0603606A	Landmine Warfare and Barrier Advanced Technology	03				17,948		17,948	U
48	0603607A	Joint Service Small Arms Program	03				5,796		5,796	U
49	0603710A	Night Vision Advanced Technology	03				47,135		47,135	U
50	0603728A	Environmental Quality Technology Demonstrations	03				10,421		10,421	U

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35	0603006A	Space Application Advanced Technology	03	13,000		13,000	U
36	0603007A	Manpower, Personnel and Training Advanced Technology	03	8,044		8,044	U
37	0603009A	TRACTOR HIKE	03	22,631		22,631	U
38	0603015A	Next Generation Training & Simulation Systems	03	25,682		25,682	U
39	0603020A	TRACTOR ROSE	03				U
40	0603125A	Combating Terrorism - Technology Development	03	3,762		3,762	U
41	0603130A	TRACTOR NAIL	03	4,896		4,896	U
42	0603131A	TRACTOR EGGS	03	6,041		6,041	U
43	0603270A	Electronic Warfare Technology	03	31,491		31,491	U
44	0603313A	Missile and Rocket Advanced Technology	03	61,132		61,132	U
45	0603322A	TRACTOR CAGE	03	16,845		16,845	U
46	0603461A	High Performance Computing Modernization Program	03	183,322		183,322	U
47	0603606A	Landmine Warfare and Barrier Advanced Technology	03	11,104		11,104	U
48	0603607A	Joint Service Small Arms Program	03	5,885		5,885	U
49	0603710A	Night Vision Advanced Technology	03	61,376		61,376	U
50	0603728A	Environmental Quality Technology Demonstrations	03	9,136		9,136	U

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51	0603734A	Military Engineering Advanced Technology	03	59,101	32,448	32,448			U
52	0603772A	Advanced Tactical Computer Science and Sensor Technology	03	52,572	52,206	52,206			U
53	0603794A	C3 Advanced Technology	03	36,439	33,426	33,426			U
		Advanced Technology Development		1,351,035	1,070,977	1,070,977			
54	0603305A	Army Missle Defense Systems Integration	04	39,395	9,634	9,634			U
55	0603308A	Army Space Systems Integration	04	32,278					U
56	0603327A	Air and Missile Defense Systems Engineering	04	6,100	33,949	33,949	15,000	15,000	U
57	0603619A	Landmine Warfare and Barrier - Adv Dev	04	65,062	72,909	72,909			U
58	0603627A	Smoke, Obscurant and Target Defeating Sys-Adv Dev	04	43,177	7,135	7,135			U
59	0603639A	Tank and Medium Caliber Ammunition	04	47,745	41,452	41,452			U
60	0603645A	Armored System Modernization - Adv Dev	04		32,739	32,739			U
61	0603747A	Soldier Support and Survivability	04	13,607	10,157	10,157	3,000	3,000	U
62	0603766A	Tactical Electronic Surveillance System - Adv Dev	04	15,730	27,733	27,733			U
63	0603774A	Night Vision Systems Advanced Development	04	9,930	12,347	12,347			U
64	0603779A	Environmental Quality Technology - Dem/Val	04	7,480	10,456	10,456			U

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51	0603734A	Military Engineering Advanced Technology	03				32,448		32,448	U
52	0603772A	Advanced Tactical Computer Science and Sensor Technology	03				52,206		52,206	U
53	0603794A	C3 Advanced Technology	03				33,426		33,426	U
		Advanced Technology Development		12,000	-12,000		1,082,977	-12,000	1,070,977	
54	0603305A	Army Missle Defense Systems Integration	04				9,634		9,634	U
55	0603308A	Army Space Systems Integration	04							U
56	0603327A	Air and Missile Defense Systems Engineering	04	8,700	-8,700		57,649	-8,700	48,949	U
57	0603619A	Landmine Warfare and Barrier - Adv Dev	04				72,909		72,909	U
58	0603627A	Smoke, Obscurant and Target Defeating Sys-Adv Dev	04				7,135		7,135	U
59	0603639A	Tank and Medium Caliber Ammunition	04				41,452		41,452	U
60	0603645A	Armored System Modernization - Adv Dev	04				32,739		32,739	U
61	0603747A	Soldier Support and Survivability	04				13,157		13,157	U
62	0603766A	Tactical Electronic Surveillance System - Adv Dev	04				27,733		27,733	U
63	0603774A	Night Vision Systems Advanced Development	04				12,347		12,347	U
64	0603779A	Environmental Quality Technology - Dem/Val	04				10,456		10,456	U

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51	0603734A	Military Engineering Advanced Technology	03	25,864		25,864	U
52	0603772A	Advanced Tactical Computer Science and Sensor Technology	03	34,883		34,883	U
53	0603794A	C3 Advanced Technology	03	52,387		52,387	U
		Advanced Technology Development		1,026,698		1,026,698	
54	0603305A	Army Missle Defense Systems Integration	04	10,777		10,777	U
55	0603308A	Army Space Systems Integration	04				U
56	0603327A	Air and Missile Defense Systems Engineering	04	42,802	1,000	43,802	U
57	0603619A	Landmine Warfare and Barrier - Adv Dev	04	45,254		45,254	U
58	0603627A	Smoke, Obscurant and Target Defeating Sys-Adv Dev	04	22,700	1,500	24,200	U
59	0603639A	Tank and Medium Caliber Ammunition	04	41,974		41,974	U
60	0603645A	Armored System Modernization - Adv Dev	04	119,395		119,395	U
61	0603747A	Soldier Support and Survivability	04	8,746	3,000	11,746	U
62	0603766A	Tactical Electronic Surveillance System - Adv Dev	04	35,667		35,667	U
63	0603774A	Night Vision Systems Advanced Development	04	7,350		7,350	U
64	0603779A	Environmental Quality Technology - Dem/Val	04	14,749		14,749	U

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65	0603790A	NATO Research and Development	04	2,211	2,588	2,588			U
66	0603801A	Aviation - Adv Dev	04	7,702	14,055	14,055			U
67	0603804A	Logistics and Engineer Equipment - Adv Dev	04	17,445	35,333	35,333			U
68	0603807A	Medical Systems - Adv Dev	04	47,336	33,491	33,491			U
69	0603827A	Soldier Systems - Advanced Development	04	54,497	20,239	20,239			U
70	0604017A	Robotics Development	04		39,608	39,608			U
71	0604020A	Cross Functional Team (CFT) Advanced Development & Prototyping	04						U
72	0604100A	Analysis Of Alternatives	04	6,354	9,921	9,921			U
73	0604113A	Future Tactical Unmanned Aircraft System (FTUAS)	04						U
74	0604114A	Lower Tier Air Missile Defense (LTAMD) Sensor	04	33,780	76,728	76,728			U
75	0604115A	Technology Maturation Initiatives	04	57,737	115,221	115,221			U
76	0604117A	Maneuver - Short Range Air Defense (M-SHORAD)	04		20,000	20,000			U
77	0604118A	TRACTOR BEAM	04		10,400	10,400			U
78	0604120A	Assured Positioning, Navigation and Timing (PNT)	04	83,074	164,967	164,967			U
79	0604121A	Synthetic Training Environment Refinement & Prototyping	04		1,600	1,600			U

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65	0603790A	NATO Research and Development	04				2,588		2,588	U
66	0603801A	Aviation - Adv Dev	04				14,055		14,055	U
67	0603804A	Logistics and Engineer Equipment - Adv Dev	04				35,333		35,333	U
68	0603807A	Medical Systems - Adv Dev	04				33,491		33,491	U
69	0603827A	Soldier Systems - Advanced Development	04				20,239		20,239	U
70	0604017A	Robotics Development	04				39,608		39,608	U
71	0604020A	Cross Functional Team (CFT) Advanced Development & Prototyping	04							U
72	0604100A	Analysis Of Alternatives	04				9,921		9,921	U
73	0604113A	Future Tactical Unmanned Aircraft System (FTUAS)	04							U
74	0604114A	Lower Tier Air Missile Defense (LTAMD) Sensor	04				76,728		76,728	U
75	0604115A	Technology Maturation Initiatives	04				115,221		115,221	U
76	0604117A	Maneuver - Short Range Air Defense (M-SHORAD)	04				20,000		20,000	U
77	0604118A	TRACTOR BEAM	04				10,400		10,400	U
78	0604120A	Assured Positioning, Navigation and Timing (PNT)	04				164,967		164,967	U
79	0604121A	Synthetic Training Environment Refinement & Prototyping	04				1,600		1,600	U

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65	0603790A	NATO Research and Development	04	3,687		3,687	U
66	0603801A	Aviation - Adv Dev	04	10,793		10,793	U
67	0603804A	Logistics and Engineer Equipment - Adv Dev	04	14,248		14,248	U
68	0603807A	Medical Systems - Adv Dev	04	34,284		34,284	U
69	0603827A	Soldier Systems - Advanced Development	04	18,044		18,044	U
70	0604017A	Robotics Development	04	95,660		95,660	U
71	0604020A	Cross Functional Team (CFT) Advanced Development & Prototyping	04	38,000		38,000	U
72	0604100A	Analysis Of Alternatives	04	9,765		9,765	U
73	0604113A	Future Tactical Unmanned Aircraft System (FTUAS)	04	12,393		12,393	U
74	0604114A	Lower Tier Air Missile Defense (LTAMD) Sensor	04	120,374		120,374	U
75	0604115A	Technology Maturation Initiatives	04	95,347		95,347	U
76	0604117A	Maneuver - Short Range Air Defense (M-SHORAD)	04	95,085	23,000	118,085	U
77	0604118A	TRACTOR BEAM	04	52,894		52,894	U
78	0604120A	Assured Positioning, Navigation and Timing (PNT)	04				U
79	0604121A	Synthetic Training Environment Refinement & Prototyping	04	77,939		77,939	U

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80	0604319A	Indirect Fire Protection Capability Increment 2-Intercept (IFPC2)	04		11,303	11,303			U
81	0305251A	Cyberspace Operations Forces and Force Support	04	29,336	56,492	56,492			U
82	1206120A	Assured Positioning, Navigation and Timing (PNT)	04						U
83	1206308A	Army Space Systems Integration	04		20,432	20,432			U
		Advanced Component Development & Prototypes		619,976	890,889	890,889	18,000	18,000	
84	0604201A	Aircraft Avionics	05	54,915	30,153	30,153			U
85	0604270A	Electronic Warfare Development	05	33,419	71,671	71,671			U
86	0604290A	Mid-tier Networking Vehicular Radio (MNVR)	05	9,363	10,589	10,589			U
87	0604321A	All Source Analysis System	05	11,958	4,774	4,774			U
88	0604328A	TRACTOR CAGE	05	12,525	17,252	17,252			U
89	0604601A	Infantry Support Weapons	05	63,842	87,643	87,643			U
90	0604604A	Medium Tactical Vehicles	05		6,039	6,039			U
91	0604611A	JAVELIN	05	19,241	21,095	21,095			U
92	0604622A	Family of Heavy Tactical Vehicles	05	10,989	10,507	10,507			U
93	0604633A	Air Traffic Control	05	3,326	3,536	3,536			U
94	0604641A	Tactical Unmanned Ground Vehicle (TUGV)	05	32,315					U
95	0604642A	Light Tactical Wheeled Vehicles	05	476	7,000	7,000			U

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80	0604319A	Indirect Fire Protection Capability Increment 2-Intercept (IFPC2)	04				11,303		11,303	U
81	0305251A	Cyberspace Operations Forces and Force Support	04				56,492		56,492	U
82	1206120A	Assured Positioning, Navigation and Timing (PNT)	04							U
83	1206308A	Army Space Systems Integration	04				20,432		20,432	U
		Advanced Component Development & Prototypes		8,700	-8,700		917,589	-8,700	908,889	
84	0604201A	Aircraft Avionics	05				30,153		30,153	U
85	0604270A	Electronic Warfare Development	05				71,671		71,671	U
86	0604290A	Mid-tier Networking Vehicular Radio (MNVR)	05				10,589		10,589	U
87	0604321A	All Source Analysis System	05				4,774		4,774	U
88	0604328A	TRACTOR CAGE	05				17,252		17,252	U
89	0604601A	Infantry Support Weapons	05				87,643		87,643	U
90	0604604A	Medium Tactical Vehicles	05				6,039		6,039	U
91	0604611A	JAVELIN	05				21,095		21,095	U
92	0604622A	Family of Heavy Tactical Vehicles	05				10,507		10,507	U
93	0604633A	Air Traffic Control	05				3,536		3,536	U
94	0604641A	Tactical Unmanned Ground Vehicle (TUGV)	05							U
95	0604642A	Light Tactical Wheeled Vehicles	05				7,000		7,000	U

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80	0604319A	Indirect Fire Protection Capability Increment 2-Intercept (IFPC2)	04	51,030		51,030	U
81	0305251A	Cyberspace Operations Forces and Force Support	04	65,817		65,817	U
82	1206120A	Assured Positioning, Navigation and Timing (PNT)	04	146,300		146,300	U
83	1206308A	Army Space Systems Integration	04	38,319		38,319	U
		Advanced Component Development & Prototypes		1,329,393	28,500	1,357,893	
84	0604201A	Aircraft Avionics	05	32,293		32,293	U
85	0604270A	Electronic Warfare Development	05	78,699		78,699	U
86	0604290A	Mid-tier Networking Vehicular Radio (MNVR)	05				U
87	0604321A	All Source Analysis System	05				U
88	0604328A	TRACTOR CAGE	05	17,050	12,000	29,050	U
89	0604601A	Infantry Support Weapons	05	83,155		83,155	U
90	0604604A	Medium Tactical Vehicles	05	3,704		3,704	U
91	0604611A	JAVELIN	05	10,623		10,623	U
92	0604622A	Family of Heavy Tactical Vehicles	05	11,950		11,950	U
93	0604633A	Air Traffic Control	05	12,347		12,347	U
94	0604641A	Tactical Unmanned Ground Vehicle (TUGV)	05				U
95	0604642A	Light Tactical Wheeled Vehicles	05	8,212		8,212	U

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96	0604645A	Armored Systems Modernization (ASM) - Eng Dev	05	9,306	36,242	36,242			U
97	0604710A	Night Vision Systems - Eng Dev	05	76,491	108,504	108,504			U
98	0604713A	Combat Feeding, Clothing, and Equipment	05	1,975	3,702	3,702			U
99	0604715A	Non-System Training Devices - Eng Dev	05	33,888	43,575	43,575			U
100	0604741A	Air Defense Command, Control and Intelligence - Eng Dev	05	200,205	28,726	28,726			U
101	0604742A	Constructive Simulation Systems Development	05	17,363	18,562	18,562			U
102	0604746A	Automatic Test Equipment Development	05	8,503	8,344	8,344			U
103	0604760A	Distributive Interactive Simulations (DIS) - Eng Dev	05	10,150	11,270	11,270			U
104	0604768A	Brilliant Anti-Armor Submunition (BAT)	05		10,000	10,000			U
105	0604780A	Combined Arms Tactical Trainer (CATT) Core	05	14,538	18,566	18,566			U
106	0604798A	Brigade Analysis, Integration and Evaluation	05	101,927	145,360	145,360			U
107	0604802A	Weapons and Munitions - Eng Dev	05	75,845	145,232	145,232			U
108	0604804A	Logistics and Engineer Equipment - Eng Dev	05	76,374	90,965	90,965			U
109	0604805A	Command, Control, Communications Systems - Eng Dev	05	4,166	9,910	9,910			U

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Line No	Program Element Number	Item	Act	FY 2018 Emergency Requests** Emergency	FY 2018 Less Enacted Div B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req Emergency	FY 2018 Total PB Requests* with CR Adj Base + OCO + Emergency**	FY 2018 Less Enacted DIV B P.L.115-96*** MDDE + Ship Repairs	FY 2018 Remaining Req with CR Adj Base + OCO + Emergency	Sec
96	0604645A	Armored Systems Modernization (ASM) - Eng Dev	05				36,242		36,242	U
97	0604710A	Night Vision Systems - Eng Dev	05				108,504		108,504	U
98	0604713A	Combat Feeding, Clothing, and Equipment	05				3,702		3,702	U
99	0604715A	Non-System Training Devices - Eng Dev	05				43,575		43,575	U
100	0604741A	Air Defense Command, Control and Intelligence - Eng Dev	05				28,726		28,726	U
101	0604742A	Constructive Simulation Systems Development	05				18,562		18,562	U
102	0604746A	Automatic Test Equipment Development	05				8,344		8,344	U
103	0604760A	Distributive Interactive Simulations (DIS) - Eng Dev	05				11,270		11,270	U
104	0604768A	Brilliant Anti-Armor Submunition (BAT)	05				10,000		10,000	U
105	0604780A	Combined Arms Tactical Trainer (CATT) Core	05				18,566		18,566	U
106	0604798A	Brigade Analysis, Integration and Evaluation	05				145,360		145,360	U
107	0604802A	Weapons and Munitions - Eng Dev	05				145,232		145,232	U
108	0604804A	Logistics and Engineer Equipment - Eng Dev	05				90,965		90,965	U
109	0604805A	Command, Control, Communications Systems - Eng Dev	05				9,910		9,910	U

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96	0604645A	Armored Systems Modernization (ASM) - Eng Dev	05	393,613		393,613	U
97	0604710A	Night Vision Systems - Eng Dev	05	139,614		139,614	U
98	0604713A	Combat Feeding, Clothing, and Equipment	05	4,507		4,507	U
99	0604715A	Non-System Training Devices - Eng Dev	05	49,436		49,436	U
100	0604741A	Air Defense Command, Control and Intelligence - Eng Dev	05	95,172	119,300	214,472	U
101	0604742A	Constructive Simulation Systems Development	05	22,628		22,628	U
102	0604746A	Automatic Test Equipment Development	05	13,297		13,297	U
103	0604760A	Distributive Interactive Simulations (DIS) - Eng Dev	05	9,145		9,145	U
104	0604768A	Brilliant Anti-Armor Submunition (BAT)	05	9,894		9,894	U
105	0604780A	Combined Arms Tactical Trainer (CATT) Core	05	21,964		21,964	U
106	0604798A	Brigade Analysis, Integration and Evaluation	05	49,288		49,288	U
107	0604802A	Weapons and Munitions - Eng Dev	05	183,100		183,100	U
108	0604804A	Logistics and Engineer Equipment - Eng Dev	05	79,706		79,706	U
109	0604805A	Command, Control, Communications Systems - Eng Dev	05	15,970		15,970	U

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110	0604807A	Medical Materiel/Medical Biological Defense Equipment - Eng Dev	05	36,237	39,238	39,238			U
111	0604808A	Landmine Warfare/Barrier - Eng Dev	05	32,069	34,684	34,684			U
112	0604818A	Army Tactical Command & Control Hardware & Software	05	169,375	164,409	164,409			U
113	0604820A	Radar Development	05	15,368	32,968	32,968			U
114	0604822A	General Fund Enterprise Business System (GFEBS)	05	11,044	49,554	49,554			U
115	0604823A	Firefinder	05	6,177	45,605	45,605			U
116	0604827A	Soldier Systems - Warrior Dem/Val	05	11,929	16,127	16,127			U
117	0604852A	Suite of Survivability Enhancement Systems - EMD	05		98,600	98,600			U
118	0604854A	Artillery Systems - EMD	05	1,689	1,972	1,972			U
119	0605013A	Information Technology Development	05	70,104	81,776	81,776			U
120	0605018A	Integrated Personnel and Pay System-Army (IPPS-A)	05	149,597	172,361	172,361			U
121	0605028A	Armored Multi-Purpose Vehicle (AMPV)	05	177,133	199,778	199,778			U
122	0605029A	Integrated Ground Security Surveillance Response Capability (IGSSR-C)	05	4,789	4,418	4,418			U
123	0605030A	Joint Tactical Network Center (JTNC)	05	14,463	15,877	15,877			U
124	0605031A	Joint Tactical Network (JTN)	05	16,430	44,150	44,150			U
125	0605032A	TRACTOR TIRE	05	27,254	34,670	34,670	5,000	5,000	U

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110	0604807A	Medical Materiel/Medical Biological Defense Equipment - Eng Dev	05				39,238		39,238	U
111	0604808A	Landmine Warfare/Barrier - Eng Dev	05				34,684		34,684	U
112	0604818A	Army Tactical Command & Control Hardware & Software	05				164,409		164,409	U
113	0604820A	Radar Development	05				32,968		32,968	U
114	0604822A	General Fund Enterprise Business System (GFEBS)	05				49,554		49,554	U
115	0604823A	Firefinder	05				45,605		45,605	U
116	0604827A	Soldier Systems - Warrior Dem/Val	05				16,127		16,127	U
117	0604852A	Suite of Survivability Enhancement Systems - EMD	05				98,600		98,600	U
118	0604854A	Artillery Systems - EMD	05				1,972		1,972	U
119	0605013A	Information Technology Development	05				81,776		81,776	U
120	0605018A	Integrated Personnel and Pay System-Army (IPPS-A)	05				172,361		172,361	U
121	0605028A	Armored Multi-Purpose Vehicle (AMPV)	05				199,778		199,778	U
122	0605029A	Integrated Ground Security Surveillance Response Capability (IGSSR-C)	05				4,418		4,418	U
123	0605030A	Joint Tactical Network Center (JTNC)	05				15,877		15,877	U
124	0605031A	Joint Tactical Network (JTN)	05				44,150		44,150	U
125	0605032A	TRACTOR TIRE	05				39,670		39,670	U

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110	0604807A	Medical Materiel/Medical Biological Defense Equipment - Eng Dev	05	44,542		44,542	U
111	0604808A	Landmine Warfare/Barrier - Eng Dev	05	50,817		50,817	U
112	0604818A	Army Tactical Command & Control Hardware & Software	05	178,693		178,693	U
113	0604820A	Radar Development	05	39,338		39,338	U
114	0604822A	General Fund Enterprise Business System (GFEBS)	05	37,851		37,851	U
115	0604823A	Firefinder	05	45,473		45,473	U
116	0604827A	Soldier Systems - Warrior Dem/Val	05	10,395		10,395	U
117	0604852A	Suite of Survivability Enhancement Systems - EMD	05	69,204		69,204	U
118	0604854A	Artillery Systems - EMD	05	1,781		1,781	U
119	0605013A	Information Technology Development	05	113,758		113,758	U
120	0605018A	Integrated Personnel and Pay System-Army (IPPS-A)	05	166,603		166,603	U
121	0605028A	Armored Multi-Purpose Vehicle (AMPV)	05	118,239		118,239	U
122	0605029A	Integrated Ground Security Surveillance Response Capability (IGSSR-C)	05	3,211		3,211	U
123	0605030A	Joint Tactical Network Center (JTNC)	05	15,889		15,889	U
124	0605031A	Joint Tactical Network (JTN)	05	41,972		41,972	U
125	0605032A	TRACTOR TIRE	05	41,166	66,760	107,926	U

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126	0605033A	Ground-Based Operational Surveillance System - Expeditionary (GBOSS-E)	05	4,838	5,207	5,207			U
127	0605034A	Tactical Security System (TSS)	05	2,792	4,727	4,727			U
128	0605035A	Common Infrared Countermeasures (CIRCM)	05	90,685	105,778	105,778	21,540	21,540	U
129	0605036A	Combating Weapons of Mass Destruction (CWMD)	05	2,008	6,927	6,927			U
130	0605037A	Evidence Collection and Detainee Processing	05		214	214			U
131	0605038A	Nuclear Biological Chemical Reconnaissance Vehicle (NBCRV) Sensor Suite	05		16,125	16,125			U
132	0605041A	Defensive CYBER Tool Development	05	32,535	55,165	55,165			U
133	0605042A	Tactical Network Radio Systems (Low-Tier)	05	14,198	20,076	20,076			U
134	0605047A	Contract Writing System	05	19,868	20,322	20,322			U
135	0605049A	Missile Warning System Modernization (MWSM)	05		55,810	55,810			U
136	0605051A	Aircraft Survivability Development	05	121,530	30,879	30,879	30,100	30,100	U
137	0605052A	Indirect Fire Protection Capability Inc 2 - Block 1	05	80,781	175,069	175,069			U
138	0605053A	Ground Robotics	05		70,760	70,760			U
139	0605054A	Emerging Technology Initiatives	05						U

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126	0605033A	Ground-Based Operational Surveillance System - Expeditionary (GBOSS-E)	05				5,207		5,207	U
127	0605034A	Tactical Security System (TSS)	05				4,727		4,727	U
128	0605035A	Common Infrared Countermeasures (CIRCM)	05				127,318		127,318	U
129	0605036A	Combating Weapons of Mass Destruction (CWMD)	05				6,927		6,927	U
130	0605037A	Evidence Collection and Detainee Processing	05				214		214	U
131	0605038A	Nuclear Biological Chemical Reconnaissance Vehicle (NBCRV) Sensor Suite	05				16,125		16,125	U
132	0605041A	Defensive CYBER Tool Development	05				55,165		55,165	U
133	0605042A	Tactical Network Radio Systems (Low-Tier)	05				20,076		20,076	U
134	0605047A	Contract Writing System	05				20,322		20,322	U
135	0605049A	Missile Warning System Modernization (MWSM)	05				55,810		55,810	U
136	0605051A	Aircraft Survivability Development	05				60,979		60,979	U
137	0605052A	Indirect Fire Protection Capability Inc 2 - Block 1	05				175,069		175,069	U
138	0605053A	Ground Robotics	05				70,760		70,760	U
139	0605054A	Emerging Technology Initiatives	05							U

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Line No	Program Element Number	Item	Act	FY 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
126	0605033A	Ground-Based Operational Surveillance System - Expeditionary (GBOSS-E)	05	5,175		5,175	U
127	0605034A	Tactical Security System (TSS)	05	4,496		4,496	U
128	0605035A	Common Infrared Countermeasures (CIRCM)	05	51,178	2,670	53,848	U
129	0605036A	Combating Weapons of Mass Destruction (CWMD)	05	11,311		11,311	U
130	0605037A	Evidence Collection and Detainee Processing	05				U
131	0605038A	Nuclear Biological Chemical Reconnaissance Vehicle (NBCRV) Sensor Suite	05	17,154		17,154	U
132	0605041A	Defensive CYBER Tool Development	05	36,626		36,626	U
133	0605042A	Tactical Network Radio Systems (Low-Tier)	05	3,829		3,829	U
134	0605047A	Contract Writing System	05	41,928		41,928	U
135	0605049A	Missile Warning System Modernization (MWSM)	05	28,276		28,276	U
136	0605051A	Aircraft Survivability Development	05	21,965	34,933	56,898	U
137	0605052A	Indirect Fire Protection Capability Inc 2 - Block 1	05	157,710		157,710	U
138	0605053A	Ground Robotics	05	86,167		86,167	U
139	0605054A	Emerging Technology Initiatives	05	42,866		42,866	U

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140	0605380A	AMF Joint Tactical Radio System (JTRS)	05	4,088	8,965	8,965			U
141	0605450A	Joint Air-to-Ground Missile (JAGM)	05	47,446	34,626	34,626			U
142	0605457A	Army Integrated Air and Missile Defense (AIAMD)	05	273,240	336,420	336,420			U
143	0605766A	National Capabilities Integration (MIP)	05	4,955	6,882	6,882			U
144	0605812A	Joint Light Tactical Vehicle (JLTV) Engineering and Manufacturing Development Ph	05	11,086	23,467	23,467			U
145	0605830A	Aviation Ground Support Equipment	05	2,060	6,930	6,930			U
146	0210609A	Paladin Integrated Management (PIM)	05	39,902	6,112	6,112			U
147	0303032A	TROJAN - RH12	05	4,273	4,431	4,431	1,200	1,200	U
148	0303267A	Auctioned Spectrum Relocation Fund	05	34,967					U
149	0303367A	Spectrum Access Research and Development	05	66,125					U
150	0304270A	Electronic Warfare Development	05	18,425	14,616	14,616			U
151	1205117A	Tractor Bears	05		17,928	17,928			U
		System Development & Demonstration		2,502,560	3,012,840	3,012,840	57,840	57,840	
152	0604256A	Threat Simulator Development	06	28,883	22,862	22,862			U
153	0604258A	Target Systems Development	06	18,518	13,902	13,902			U
154	0604759A	Major T&E Investment	06	93,668	102,901	102,901			U
155	0605103A	Rand Arroyo Center	06	19,863	20,140	20,140			U

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140	0605380A	AMF Joint Tactical Radio System (JTRS)	05				8,965		8,965	U
141	0605450A	Joint Air-to-Ground Missile (JAGM)	05				34,626		34,626	U
142	0605457A	Army Integrated Air and Missile Defense (AIAMD)	05				336,420		336,420	U
143	0605766A	National Capabilities Integration (MIP)	05				6,882		6,882	U
144	0605812A	Joint Light Tactical Vehicle (JLTV) Engineering and Manufacturing Development Ph	05				23,467		23,467	U
145	0605830A	Aviation Ground Support Equipment	05				6,930		6,930	U
146	0210609A	Paladin Integrated Management (PIM)	05				6,112		6,112	U
147	0303032A	TROJAN - RH12	05				5,631		5,631	U
148	0303267A	Auctioned Spectrum Relocation Fund	05							U
149	0303367A	Spectrum Access Research and Development	05							U
150	0304270A	Electronic Warfare Development	05				14,616		14,616	U
151	1205117A	Tractor Bears	05				17,928		17,928	U
		System Development & Demonstration					3,070,680		3,070,680	
152	0604256A	Threat Simulator Development	06				22,862		22,862	U
153	0604258A	Target Systems Development	06				13,902		13,902	U
154	0604759A	Major T&E Investment	06				102,901		102,901	U
155	0605103A	Rand Arroyo Center	06				20,140		20,140	U

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140	0605380A	AMF Joint Tactical Radio System (JTRS)	05	15,984		15,984	U
141	0605450A	Joint Air-to-Ground Missile (JAGM)	05	11,773		11,773	U
142	0605457A	Army Integrated Air and Missile Defense (AIAMD)	05	277,607		277,607	U
143	0605766A	National Capabilities Integration (MIP)	05	12,340		12,340	U
144	0605812A	Joint Light Tactical Vehicle (JLTV) Engineering and Manufacturing Development Ph	05	2,686		2,686	U
145	0605830A	Aviation Ground Support Equipment	05	2,706		2,706	U
146	0210609A	Paladin Integrated Management (PIM)	05				U
147	0303032A	TROJAN - RH12	05	4,521	1,200	5,721	U
148	0303267A	Auctioned Spectrum Relocation Fund	05				U
149	0303367A	Spectrum Access Research and Development	05				U
150	0304270A	Electronic Warfare Development	05	8,922		8,922	U
151	1205117A	Tractor Bears	05	23,170		23,170	U
		System Development & Demonstration		3,192,689	236,863	3,429,552	
152	0604256A	Threat Simulator Development	06	12,835		12,835	U
153	0604258A	Target Systems Development	06	12,135		12,135	U
154	0604759A	Major T&E Investment	06	82,996		82,996	U
155	0605103A	Rand Arroyo Center	06	19,821		19,821	U

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156	0605301A	Army Kwajalein Atoll	06	219,271	246,663	246,663			U
157	0605326A	Concepts Experimentation Program	06	24,668	29,820	29,820			U
158	0605502A	Small Business Innovative Research	06	230,691					U
159	0605601A	Army Test Ranges and Facilities	06	305,238	307,588	307,588			U
160	0605602A	Army Technical Test Instrumentation and Targets	06	70,523	49,242	49,242			U
161	0605604A	Survivability/Lethality Analysis	06	38,245	41,843	41,843			U
162	0605606A	Aircraft Certification	06	4,486	4,804	4,804			U
163	0605702A	Meteorological Support to RDT&E Activities	06	6,793	7,238	7,238			U
164	0605706A	Materiel Systems Analysis	06	21,510	21,890	21,890			U
165	0605709A	Exploitation of Foreign Items	06	12,415	12,684	12,684			U
166	0605712A	Support of Operational Testing	06	49,580	51,040	51,040			U
167	0605716A	Army Evaluation Center	06	55,460	56,246	56,246			U
168	0605718A	Army Modeling & Sim X-Cmd Collaboration & Integ	06	7,653	1,829	1,829			U
169	0605801A	Programwide Activities	06	50,971	55,060	55,060			U
170	0605803A	Technical Information Activities	06	29,905	33,934	33,934			U
171	0605805A	Munitions Standardization, Effectiveness and Safety	06	63,983	43,444	43,444			U
172	0605857A	Environmental Quality Technology Mgmt Support	06	2,048	5,087	5,087			U

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156	0605301A	Army Kwajalein Atoll	06				246,663		246,663	U
157	0605326A	Concepts Experimentation Program	06				29,820		29,820	U
158	0605502A	Small Business Innovative Research	06							U
159	0605601A	Army Test Ranges and Facilities	06				307,588		307,588	U
160	0605602A	Army Technical Test Instrumentation and Targets	06				49,242		49,242	U
161	0605604A	Survivability/Lethality Analysis	06				41,843		41,843	U
162	0605606A	Aircraft Certification	06				4,804		4,804	U
163	0605702A	Meteorological Support to RDT&E Activities	06				7,238		7,238	U
164	0605706A	Materiel Systems Analysis	06				21,890		21,890	U
165	0605709A	Exploitation of Foreign Items	06				12,684		12,684	U
166	0605712A	Support of Operational Testing	06				51,040		51,040	U
167	0605716A	Army Evaluation Center	06				56,246		56,246	U
168	0605718A	Army Modeling & Sim X-Cmd Collaboration & Integ	06				1,829		1,829	U
169	0605801A	Programwide Activities	06				55,060		55,060	U
170	0605803A	Technical Information Activities	06				33,934		33,934	U
171	0605805A	Munitions Standardization, Effectiveness and Safety	06				43,444		43,444	U
172	0605857A	Environmental Quality Technology Mgmt Support	06				5,087		5,087	U

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156	0605301A	Army Kwajalein Atoll	06	246,574		246,574	U
157	0605326A	Concepts Experimentation Program	06	30,430		30,430	U
158	0605502A	Small Business Innovative Research	06				U
159	0605601A	Army Test Ranges and Facilities	06	305,759		305,759	U
160	0605602A	Army Technical Test Instrumentation and Targets	06	62,379		62,379	U
161	0605604A	Survivability/Lethality Analysis	06	40,496		40,496	U
162	0605606A	Aircraft Certification	06	3,941		3,941	U
163	0605702A	Meteorological Support to RDT&E Activities	06	9,767		9,767	U
164	0605706A	Materiel Systems Analysis	06	21,226		21,226	U
165	0605709A	Exploitation of Foreign Items	06	13,026		13,026	U
166	0605712A	Support of Operational Testing	06	52,718		52,718	U
167	0605716A	Army Evaluation Center	06	57,049		57,049	U
168	0605718A	Army Modeling & Sim X-Cmd Collaboration & Integ	06	2,801		2,801	U
169	0605801A	Programwide Activities	06	60,942		60,942	U
170	0605803A	Technical Information Activities	06	29,050		29,050	U
171	0605805A	Munitions Standardization, Effectiveness and Safety	06	42,332		42,332	U
172	0605857A	Environmental Quality Technology Mgmt Support	06	3,216		3,216	U

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173	0605898A	Army Direct Report Headquarters - R&D - MHA	06	49,287	54,679	54,679			U
174	0606001A	Military Ground-Based CREW Technology	06		7,916	7,916			U
175	0606002A	Ronald Reagan Ballistic Missile Defense Test Site	06		61,254	61,254			U
176	0606003A	CounterIntel and Human Intel Modernization	06						U
177	0606942A	Assessments and Evaluations Cyber Vulnerabilities	06						U
178	0303260A	Defense Military Deception Initiative	06	1,923	1,779	1,779			U
179	0909980A	Judgment Fund Reimbursement	06	7,893					U
180	0909999A	Financing for Cancelled Account Adjustments	06	6					U
	RDT&E	Management Support		1,413,481	1,253,845	1,253,845			
181	0603778A	MLRS Product Improvement Program	07	34,391	8,929	8,929			U
182	0603813A	TRACTOR PULL	07	3,960	4,014	4,014			U
183	0605024A	Anti-Tamper Technology Support	07	3,498	4,094	4,094			U
184	0607131A	Weapons and Munitions Product Improvement Programs	07	19,969	15,738	15,738			U
185	0607133A	TRACTOR SMOKE	07	4,479	4,513	4,513			U
186	0607134A	Long Range Precision Fires (LRPF)	07	36,322	102,014	102,014			U
187	0607135A	Apache Product Improvement Program	07	60,995	59,977	59,977			U

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173	0605898A	Army Direct Report Headquarters - R&D - MHA	06				54,679		54,679	U
174	0606001A	Military Ground-Based CREW Technology	06				7,916		7,916	U
175	0606002A	Ronald Reagan Ballistic Missile Defense Test Site	06				61,254		61,254	U
176	0606003A	CounterIntel and Human Intel Modernization	06							U
177	0606942A	Assessments and Evaluations Cyber Vulnerabilities	06							U
178	0303260A	Defense Military Deception Initiative	06				1,779		1,779	U
179	0909980A	Judgment Fund Reimbursement	06							U
180	0909999A	Financing for Cancelled Account Adjustments	06							U
	RDT&E	Management Support					1,253,845		1,253,845	
181	0603778A	MLRS Product Improvement Program	07				8,929		8,929	U
182	0603813A	TRACTOR PULL	07				4,014		4,014	U
183	0605024A	Anti-Tamper Technology Support	07				4,094		4,094	U
184	0607131A	Weapons and Munitions Product Improvement Programs	07				15,738		15,738	U
185	0607133A	TRACTOR SMOKE	07				4,513		4,513	U
186	0607134A	Long Range Precision Fires (LRPF)	07				102,014		102,014	U
187	0607135A	Apache Product Improvement Program	07				59,977		59,977	U

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173	0605898A	Army Direct Report Headquarters - R&D - MHA	06	54,145		54,145	U
174	0606001A	Military Ground-Based CREW Technology	06	4,896		4,896	U
175	0606002A	Ronald Reagan Ballistic Missile Defense Test Site	06	63,011		63,011	U
176	0606003A	CounterIntel and Human Intel Modernization	06	2,636		2,636	U
177	0606942A	Assessments and Evaluations Cyber Vulnerabilities	06	88,300		88,300	U
178	0303260A	Defense Military Deception Initiative	06				U
179	0909980A	Judgment Fund Reimbursement	06				U
180	0909999A	Financing for Cancelled Account Adjustments	06				U
	RDT&E	Management Support		1,322,481		1,322,481	
181	0603778A	MLRS Product Improvement Program	07	8,886		8,886	U
182	0603813A	TRACTOR PULL	07	4,067		4,067	U
183	0605024A	Anti-Tamper Technology Support	07	4,254		4,254	U
184	0607131A	Weapons and Munitions Product Improvement Programs	07	16,022	2,548	18,570	U
185	0607133A	TRACTOR SMOKE	07	4,577	7,780	12,357	U
186	0607134A	Long Range Precision Fires (LRPF)	07	186,475		186,475	U
187	0607135A	Apache Product Improvement Program	07	31,049		31,049	U

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188	0607136A	Blackhawk Product Improvement Program	07	44,966	34,416	34,416			U
189	0607137A	Chinook Product Improvement Program	07	88,314	194,567	194,567			U
190	0607138A	Fixed Wing Product Improvement Program	07	765	9,981	9,981			U
191	0607139A	Improved Turbine Engine Program	07	111,638	204,304	204,304			U
192	0607140A	Emerging Technologies from NIE	07	2,278	1,023	1,023			U
193	0607141A	Logistics Automation	07	1,542	1,504	1,504			U
194	0607142A	Aviation Rocket System Product Improvement and Development	07		10,064	10,064			U
195	0607143A	Unmanned Aircraft System Universal Products	07		38,463	38,463			U
196	0607665A	Family of Biometrics	07	11,632	6,159	6,159			U
197	0607865A	Patriot Product Improvement	07	48,073	90,217	90,217			U
198	0202429A	Aerostat Joint Project - COCOM Exercise	07	6,178	6,749	6,749			U
199	0203728A	Joint Automated Deep Operation Coordination System (JADOCS)	07	29,412	33,520	33,520			U
200	0203735A	Combat Vehicle Improvement Programs	07	340,353	343,175	343,175			U
201	0203740A	Maneuver Control System	07	3,943	6,639	6,639			U
202	0203743A	155mm Self-Propelled Howitzer Improvements	07		40,784	40,784			U
203	0203744A	Aircraft Modifications/Product Improvement Programs	07	32,397	39,358	39,358			U

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188	0607136A	Blackhawk Product Improvement Program	07				34,416		34,416	U
189	0607137A	Chinook Product Improvement Program	07				194,567		194,567	U
190	0607138A	Fixed Wing Product Improvement Program	07				9,981		9,981	U
191	0607139A	Improved Turbine Engine Program	07				204,304		204,304	U
192	0607140A	Emerging Technologies from NIE	07				1,023		1,023	U
193	0607141A	Logistics Automation	07				1,504		1,504	U
194	0607142A	Aviation Rocket System Product Improvement and Development	07				10,064		10,064	U
195	0607143A	Unmanned Aircraft System Universal Products	07				38,463		38,463	U
196	0607665A	Family of Biometrics	07				6,159		6,159	U
197	0607865A	Patriot Product Improvement	07				90,217		90,217	U
198	0202429A	Aerostat Joint Project - COCOM Exercise	07				6,749		6,749	U
199	0203728A	Joint Automated Deep Operation Coordination System (JADOCS)	07				33,520		33,520	U
200	0203735A	Combat Vehicle Improvement Programs	07				343,175		343,175	U
201	0203740A	Maneuver Control System	07				6,639		6,639	U
202	0203743A	155mm Self-Propelled Howitzer Improvements	07				40,784		40,784	U
203	0203744A	Aircraft Modifications/Product Improvement Programs	07				39,358		39,358	U

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188	0607136A	Blackhawk Product Improvement Program	07	35,240		35,240	U
189	0607137A	Chinook Product Improvement Program	07	157,822		157,822	U
190	0607138A	Fixed Wing Product Improvement Program	07	4,189		4,189	U
191	0607139A	Improved Turbine Engine Program	07	192,637		192,637	U
192	0607140A	Emerging Technologies from NIE	07				U
193	0607141A	Logistics Automation	07				U
194	0607142A	Aviation Rocket System Product Improvement and Development	07	60,860		60,860	U
195	0607143A	Unmanned Aircraft System Universal Products	07	52,019		52,019	U
196	0607665A	Family of Biometrics	07	2,400		2,400	U
197	0607865A	Patriot Product Improvement	07	65,369		65,369	U
198	0202429A	Aerostat Joint Project - COCOM Exercise	07	1		1	U
199	0203728A	Joint Automated Deep Operation Coordination System (JADOCS)	07	30,954		30,954	U
200	0203735A	Combat Vehicle Improvement Programs	07	411,927		411,927	U
201	0203740A	Maneuver Control System	07				U
202	0203743A	155mm Self-Propelled Howitzer Improvements	07	40,676		40,676	U
203	0203744A	Aircraft Modifications/Product Improvement Programs	07	17,706		17,706	U

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204	0203752A	Aircraft Engine Component Improvement Program	07	249	145	145			U
205	0203758A	Digitization	07	6,234	4,803	4,803			U
206	0203801A	Missile/Air Defense Product Improvement Program	07	24,925	2,723	2,723	15,000	15,000	U
207	0203802A	Other Missile Product Improvement Programs	07	8,283	5,000	5,000			U
208	0203808A	TRACTOR CARD	07	20,333	37,883	37,883			U
209	0205402A	Integrated Base Defense - Operational System Dev	07	3,450					U
210	0205410A	Materials Handling Equipment	07	119	1,582	1,582			U
211	0205412A	Environmental Quality Technology - Operational System Dev	07		195	195			U
212	0205456A	Lower Tier Air and Missile Defense (AMD) System	07	61,449	78,926	78,926			U
213	0205778A	Guided Multiple-Launch Rocket System (GMLRS)	07	21,196	102,807	102,807			U
214	0208053A	Joint Tactical Ground System	07	12,649					U
216	0303028A	Security and Intelligence Activities	07	15,719	13,807	13,807			U
217	0303140A	Information Systems Security Program	07	36,892	132,438	132,438			U
218	0303141A	Global Combat Support System	07	26,176	64,370	64,370			U
219	0303142A	SATCOM Ground Environment (SPACE)	07	18,761					U
220	0303150A	WWMCCS/Global Command and Control System	07	4,536	10,475	10,475			U

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204	0203752A	Aircraft Engine Component Improvement Program	07				145		145	U
205	0203758A	Digitization	07				4,803		4,803	U
206	0203801A	Missile/Air Defense Product Improvement Program	07				17,723		17,723	U
207	0203802A	Other Missile Product Improvement Programs	07				5,000		5,000	U
208	0203808A	TRACTOR CARD	07				37,883		37,883	U
209	0205402A	Integrated Base Defense - Operational System Dev	07							U
210	0205410A	Materials Handling Equipment	07				1,582		1,582	U
211	0205412A	Environmental Quality Technology - Operational System Dev	07				195		195	U
212	0205456A	Lower Tier Air and Missile Defense (AMD) System	07				78,926		78,926	U
213	0205778A	Guided Multiple-Launch Rocket System (GMLRS)	07				102,807		102,807	U
214	0208053A	Joint Tactical Ground System	07							U
216	0303028A	Security and Intelligence Activities	07				13,807		13,807	U
217	0303140A	Information Systems Security Program	07				132,438		132,438	U
218	0303141A	Global Combat Support System	07				64,370		64,370	U
219	0303142A	SATCOM Ground Environment (SPACE)	07							U
220	0303150A	WWMCCS/Global Command and Control System	07				10,475		10,475	U

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Line No	Program Element Number	Item	Act	FY 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
204	0203752A	Aircraft Engine Component Improvement Program	07	146		146	U
205	0203758A	Digitization	07	6,316		6,316	U
206	0203801A	Missile/Air Defense Product Improvement Program	07	1,643	2,000	3,643	U
207	0203802A	Other Missile Product Improvement Programs	07	4,947		4,947	U
208	0203808A	TRACTOR CARD	07	34,050		34,050	U
209	0205402A	Integrated Base Defense - Operational System Dev	07		8,000	8,000	U
210	0205410A	Materials Handling Equipment	07	1,464		1,464	U
211	0205412A	Environmental Quality Technology - Operational System Dev	07	249		249	U
212	0205456A	Lower Tier Air and Missile Defense (AMD) System	07	79,283		79,283	U
213	0205778A	Guided Multiple-Launch Rocket System (GMLRS)	07	154,102		154,102	U
214	0208053A	Joint Tactical Ground System	07				U
216	0303028A	Security and Intelligence Activities	07	12,280	23,199	35,479	U
217	0303140A	Information Systems Security Program	07	68,533		68,533	U
218	0303141A	Global Combat Support System	07	68,619		68,619	U
219	0303142A	SATCOM Ground Environment (SPACE)	07				U
220	0303150A	WWMCCS/Global Command and Control System	07	2,034		2,034	U

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223	0305172A	Combined Advanced Applications	07		1,100	1,100			U
224	0305179A	Integrated Broadcast Service (IBS)	07						U
225	0305204A	Tactical Unmanned Aerial Vehicles	07	8,218	9,433	9,433	7,492	7,492	U
226	0305206A	Airborne Reconnaissance Systems	07	11,799	5,080	5,080	15,000	15,000	U
227	0305208A	Distributed Common Ground/Surface Systems	07	32,284	24,700	24,700			U
228	0305219A	MQ-1C Gray Eagle UAS	07	13,470	9,574	9,574			U
229	0305232A	RQ-11 UAV	07	1,613	2,191	2,191			U
230	0305233A	RQ-7 UAV	07	4,597	12,773	12,773			U
231	0307665A	Biometrics Enabled Intelligence	07	8,854	2,537	2,537	6,036	6,036	U
232	0310349A	Win-T Increment 2 - Initial Networking	07	4,680	4,723	4,723			U
233	0708045A	End Item Industrial Preparedness Activities	07	59,891	60,877	60,877			U
234	1203142A	SATCOM Ground Environment (SPACE)	07		11,959	11,959			U
235	1208053A	Joint Tactical Ground System	07		10,228	10,228			U
9999	9999999999	Classified Programs		4,625	7,154	7,154			U
		Operational Systems Development		1,296,107	1,877,685	1,877,685	43,528	43,528	
236	0901560A	Continuing Resolution Programs	20		-1,151,993	-1,151,993	222,988	222,988	U
		Undistributed			-1,151,993	-1,151,993	222,988	222,988	
Total Research, Development, Test & Eval, Army				8,852,507	8,273,447	8,273,447	342,356	342,356	

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223	0305172A	Combined Advanced Applications	07				1,100		1,100	U
224	0305179A	Integrated Broadcast Service (IBS)	07							U
225	0305204A	Tactical Unmanned Aerial Vehicles	07				16,925		16,925	U
226	0305206A	Airborne Reconnaissance Systems	07				20,080		20,080	U
227	0305208A	Distributed Common Ground/Surface Systems	07				24,700		24,700	U
228	0305219A	MQ-1C Gray Eagle UAS	07				9,574		9,574	U
229	0305232A	RQ-11 UAV	07				2,191		2,191	U
230	0305233A	RQ-7 UAV	07				12,773		12,773	U
231	0307665A	Biometrics Enabled Intelligence	07				8,573		8,573	U
232	0310349A	Win-T Increment 2 - Initial Networking	07				4,723		4,723	U
233	0708045A	End Item Industrial Preparedness Activities	07				60,877		60,877	U
234	1203142A	SATCOM Ground Environment (SPACE)	07				11,959		11,959	U
235	1208053A	Joint Tactical Ground System	07				10,228		10,228	U
9999	9999999999	Classified Programs					7,154		7,154	U
		Operational Systems Development					1,921,213		1,921,213	
236	0901560A	Continuing Resolution Programs	20				-929,005		-929,005	U
		Undistributed					-929,005		-929,005	
Total Research, Development, Test & Eval, Army				20,700	-20,700		8,636,503	-20,700	8,615,803	

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Line No	Program Element Number	Item	Act	FY 2019 Base	FY 2019 OCO	FY 2019 Total	Sec
223	0305172A	Combined Advanced Applications	07	1,500		1,500	U
224	0305179A	Integrated Broadcast Service (IBS)	07	450		450	U
225	0305204A	Tactical Unmanned Aerial Vehicles	07	6,000		6,000	U
226	0305206A	Airborne Reconnaissance Systems	07	12,416	14,000	26,416	U
227	0305208A	Distributed Common Ground/Surface Systems	07	38,667		38,667	U
228	0305219A	MQ-1C Gray Eagle UAS	07				U
229	0305232A	RQ-11 UAV	07	6,180		6,180	U
230	0305233A	RQ-7 UAV	07	12,863		12,863	U
231	0307665A	Biometrics Enabled Intelligence	07	4,310	2,214	6,524	U
232	0310349A	Win-T Increment 2 - Initial Networking	07				U
233	0708045A	End Item Industrial Preparedness Activities	07	53,958		53,958	U
234	1203142A	SATCOM Ground Environment (SPACE)	07	12,119		12,119	U
235	1208053A	Joint Tactical Ground System	07	7,400		7,400	U
9999	9999999999	Classified Programs		5,955		5,955	U
		Operational Systems Development		1,922,614	59,741	1,982,355	
236	0901560A	Continuing Resolution Programs	20				U
		Undistributed					
Total Research, Development, Test & Eval, Army				10,159,379	325,104	10,484,483	

R-119PB: FY 2019 President's Budget (Published Version), as of January 18, 2018 at 15:06:20

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16	02	0602622A	Chemical, Smoke and Equipment Defeating Tech	117
17	02	0602623A	Joint Service Small Arms Program (JSSAP)	121
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26	02	0602784A	Military Engineering Technology	232
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28	02	0602786A	Warfighter Technology	260
29	02	0602787A	Medical Technology	277

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Program Element Title	Program Element Number	Line #	BA	Page
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Advanced Weapons Technology	0602307A	12	02	67
Aviation Technology	0602211A	9	02	31
Ballistics Technology	0602618A	15	02	105
Chemical, Smoke and Equipment Defeating Tech	0602622A	16	02	117
Combat Vehicle and Automotive Technology	0602601A	14	02	87
Command, Control, Communications Technology	0602782A	24	02	209
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Countermine Systems	0602712A	21	02	176
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Joint Service Small Arms Program (JSSAP)	0602623A	17	02	121
Manpower/Personnel/Training Technology	0602785A	27	02	256
Materials Technology	0602105A	5	02	1
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Program Element Title	Program Element Number	Line #	BA	Page
Military Engineering Technology	0602784A	26	02	232
Missile Technology	0602303A	11	02	56
Night Vision Technology	0602709A	20	02	168
Sensors & Electronic Survivability	0602120A	6	02	12
TRACTOR JACK	0602126A	8	02	30
Tractor Hip	0602122A	7	02	27
Warfighter Technology	0602786A	28	02	260
Weapons and Munitions Technology	0602624A	18	02	125

FY 2019 RDT&E, ARMY PROGRAM ELEMENT

DESCRIPTIVE SUMMARIES

Introduction and Explanation of Contents

1. **General.** The purpose of this document is to provide summary information concerning the Research, Development, Test and Evaluation, Army program. The descriptive summaries are comprised of R-2 (Army RDT&E Budget Item Justification – program element level), R-2A (Army RDT&E Budget Item Justification – project level), R-3 (Army RDT&E Cost Analysis), R-4 (Schedule Profile Detail) and R-5 (Termination Liability Funding for MDAPs) Exhibits, which provide narrative information on all RDT&E program elements and projects through FY 2019.

2. **Relationship of the FY 2019 Budget Submitted to Congress to the FY 2018 Budget Submitted to Congress.** This paragraph provides a list of program elements/projects that are major new starts, restructures, developmental transitions, and terminated programs. Explanations for these changes can be found in the narrative sections of the Program Element R-2A Exhibits.

A. New Start Programs:

Budget Activity	OSDPE / Project	Project Title
02	0602126A / XW8	TRACTOR JACK
02	0602787A / XV5	Medical Capabilities to Support Dispersed Ops
04	0604020A / CF1	CFT Advanced Development & Prototyping
04	0604113A / EX8	Future Tactical Unmanned Aircraft System (FTUAS)
06	0605898A / FJ2	Army SHARP RDTE
06	0606942A / FL2	Cyber Vulnerabilities Assessments and Evaluations
07	0305179A / EF4	Integrated Broadcast System
07	0305206A / EH7	Guardrail Common Sensor (GRCS) Payloads (MIP)
07	0305206A / EH2	EMARSS ADV DEV (MIP)

B. Program Element/Project Restructures:

Budget Activity	Old OSDPE / Project: Title	New OSDPE / Project: Title
02	0602105A / H84: Materials	0602105A / XW4: Manufacturing Science
02	0602270A / 906: Tactical Electronic Warfare Applied Research	0602270A / CYB: Applied Offensive Cyber
02	0602782A / 779: Command, Control And Platform Electronics Tech	0602782A / CY2: Applied Defensive Cyber
02	0602782A / H92: Communications Technology	0602782A / CY2: Applied Defensive Cyber
02	0602786A / 283: Airdrop Adv Tech	0602786A / XW5: Small Unit Expeditionary Maneuver Technology
02	0602786A / H99: Joint Service Combat Feeding Technology	0602786A / XW5: Small Unit Expeditionary Maneuver Technology
02	0602786A / VT4: Expeditionary Mobile Base Camp Technology	0602786A / XW5: Small Unit Expeditionary Maneuver Technology
03	0603001A / C07: Joint Service Combat Feeding Tech Demo	0603001A / XW6: Small Unit Expeditionary Maneuver
03	0603001A / VT5: Expeditionary Mobile Base Camp Demonstration	0603001A / XW6: Small Unit Expeditionary Maneuver
03	0603001A / 242: Airdrop Equipment	0603001A / XW6: Small Unit Expeditionary Maneuver
03	0603270A / K15: Advanced Comm Ecm Demo	0603270A / CY3: Offensive Cyber Demonstration
03	0603270A / K16: Non-Commo Ecm Tech Dem	0603270A / CY3: Offensive Cyber Demonstration
04	0603639A / EL7: Reduced Range Ammunition	0604802A / EP3: Reduced Range Ammunition - Small Caliber
04	0603639A / EL8: LIGHTWEIGHT CARTRIDGE CASE FOR SMALL CALIBER	0607131A / ER6: Direct Fire Technology
04	0603639A / EU1: Enhanced Lethality Cannon Munitions	0604802A / EU7: Enhanced Lethality Cannon Munitions
04	0603639A / EU1: Enhanced Lethality Cannon Munitions	0604802A / EU6: 155mm HE Rocket Assist Project Extended Range
04	0604120A / ED5: Assured Positioning, Navigation and Timing (PNT)	1206120A / FJ8: Assured Positioning, Navigation and Timing (PNT)
04	0604120A / EH8: DISMOUNTED	1206120A / FJ9: Dismounted A-PNT
04	0604120A / EH9: PSEUDOLITES	1206120A / FK1: Pseudolites
04	0604120A / EJ2: MOUNTED	1206120A / FK2: Mounted A-PNT
04	0604120A / EJ3: ANTI-JAM ANTENNA	1206120A / FK3: Anti-Jam Antenna
05	0210609A / ED8: Paladin Integrated Management (PIM)	0203743A / FF9: PIM Improvement Program
05	0604798A / FG7: Emerging Technology Initiatives	0604798A / FI3: Rapid Capability Development and Maturation
05	0604827A / S65: Platoon Power Generator	0604827A / EY3: Soldier Power Generator
05	0605053A / FB4: Common Robotic Systems	0605053A / FG8: Common Robotic Controller
07	0303028A / FG2: Counterintelligence & Human Intel Modernization	0606003A / FI9: Counterl Intel and Human Intel Modernization
07	0205402A / EF2: Integrated Base Defense	0605029A / EQ2: IntegGrdSecSurvRespC(IGSSR-C)
07	0205402A / EF2: Integrated Base Defense	0605033A / EQ3: Grnd-Based Opnl Surv Sys -Exped (GBOSS-E)
07	0303142A / 253: Dscs-Dcs (Phase II)	1203142A / FE1: Dscs-Dcs (Phase II)
07	0303142A / 456: MILSATCOM System Engineering	1203142A / FE2: MILSATCOM System Engineering
07	0303142A / EK8: Enroute Mission Command	1203142A / FE4: Enroute Mission Command

C. Program Terminations:

Budget Activity	OSDPE / Project	OSDPE Title / Project Title
01	0601103A / V72	University Research Initiatives / Minerva; project ends
01	0601104A / H50	University and Industry Research Centers / Network Sciences Cta; project ends
01	0601104A / H53	University and Industry Research Centers / Army High Performance Computing Research Center; project ends
01	0601104A / H54	University and Industry Research Centers / Micro-Autonomous Systems Technology (MAST) CTA; project ends
02	0602105A / H7G	Materials Technology / Nanomaterials Applied Research; project ends
02	0602120A / SA2	Sensors and Electronic Survivability / Biotechnology Applied Research; project ends
02	0602705A / H17	Electronics and Electronic Devices / Flexible Display Center; project ends
02	0602720A / 895	Environmental Quality Technology / Pollution Prevention; project ends
03	0603001A / 543	Warfighter Advanced Technology / Ammunition Logistics; project ends
03	0603015A / S28	Next Generation Training & Simulation Systems / Immersive Learning Environments; project ends
03	0603020A / DB1	TRACTOR ROSE / DDB1; project ends
03	0603606A / 683	Landmine Warfare and Barrier Advanced Technology / Area Denial Sensors; project ends
03	0603728A / 025	Environmental Quality Technology Demonstrations / Pollution Prevention Technology; project ends
04	0604115A / EX3	Technology Maturation Initiatives / Ground Vehicle Prototyping; project ends
05	0604290A / DW1	Mid-tier Networking Vehicular Radio (MNVR) / Mid-Tier Wideband Networking Vehicular Radio Mnvr; project ends
05	0604321A / B41	All Source Analysis System / CI/HUMINT Software Products (MIP); project ends
05	0604321A / B51	All Source Analysis System / Machine - Foreign Language Translation System; project ends
05	0604818A / 334	Army Tactical Command & Control Hardware & Software / Common Software; project ends
06	0303260A / FA9	Defense Military Deception Initiative / Security Initiatives; project ends
06	0604759A / FA4	Major T&E Investment / Warrior Injury Assessment Manikin (WIAMan); transitions to procurement
07	0202429A / EP8	Aerostat Joint Project - COCOM Exercise / COCOM Exercise; project ends
07	0203740A / 484	Maneuver Control System / Maneuver Control System; project ends
07	0303142A / EA3	SATCOM Ground Environment (SPACE) / Transportable Tactical Cmd Comms (T2C2); transitions to procurement
07	0303150A / EA5	WWMCCS/Global Command and Control System / Strategic and Joint Mission Command; transitions to procurement
07	0305219A / MQ1	MQ-1 Gray Eagle UAV / MQ-1 Gray Eagle - Army UAV (MIP); project ends
07	0607140A / ES7	Emerging Technologies from NIE / Emerging Technologies from NIE; project ends
07	0607141A / DY1	Logistics Automation / Logistics Information Warehouse (LIW); project ends

3. Classification: This document contains no classified data Appropriately cleared individuals can obtain further information on Classified/Special Access Programs by contacting the Department of the Army (ASA(ALT)) Special Programs Office.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602105A *I Materials Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	81.950	29.640	28.600	-	28.600	28.823	31.268	33.017	34.894	0.000	268.192
H7B: *Advanced Materials Initiatives (CA)*	-	51.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	51.000
H7G: *Nanomaterials Applied Research*	-	3.321	3.107	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	6.428
H84: *Materials*	-	27.629	26.533	24.100	-	24.100	23.823	25.672	27.079	28.613	0.000	183.449
XW4: *Manufacturing Science*	-	0.000	0.000	4.500	-	4.500	5.000	5.596	5.938	6.281	0.000	27.315

A. Mission Description and Budget Item Justification

This Program Element (PE) conducts fundamental research relevant to the Soldier focused on new materials, properties and phenomena in four research areas: (1) lightweight materials and hybrid assemblies for enhanced expeditionary operations, (2) materials and mechanisms that mitigate effects from blast and ballistic threats, (3) materials for augmented soldier protection and situational awareness, and (4) multifunctional materials with integrated structure, power storage, communications, sensing,and/or propulsion to provide system level efficiencies. This project funds collaborative applied research and integration of government, academic, and industry scientific research to advance innovative capabilities.

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

Work in this PE builds on the materials research transitioned from PE 0601102A and 0601104A. This work complements and is fully coordinated with PE 0602618A (Ballistics Technology), PE 0602786A (Warfighter Technology), and PE 0603001A (Warfighter Advanced Technology).

The cited work is consistent with the S&T priorities of the U.S. Army Chief of Staff, 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 Research, Development, and Engineering Command (RDECOM).

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army	Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602105A *I Materials Technology*

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	31.533	29.640	29.120	-	29.120
Current President's Budget	81.950	29.640	28.600	-	28.600
Total Adjustments	50.417	0.000	-0.520	-	-0.520
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	51.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.575	-			
• Adjustments to Budget Years	-	-	-0.520	-	-0.520
• FFRDC	-0.008	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: H7B: *Advanced Materials Initiatives (CA)*		
Congressional Add: *Congressional Program Increase*	31.000	-
Congressional Add: *High Performance Polymers Research*	20.000	-
Congressional Add Subtotals for Project: H7B	51.000	-
Congressional Add Totals for all Projects	51.000	-

Change Summary Explanation

FY 17 Congressional increase in H7B Materials Technology

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602105A / *Materials Technology*	Project (Number/Name) H7B / *Advanced Materials Initiatives (CA)*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H7B: *Advanced Materials Initiatives (CA)*	-	51.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	51.000

Note

Congressional Increase

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Advanced Materials Initiatives.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Congressional Program Increase ***FY 2017 Accomplishments:*** N/A	31.000	-
Congressional Add: High Performance Polymers Research ***FY 2017 Accomplishments:*** N/A	20.000	-
Congressional Adds Subtotals	51.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040 / 2				R-1 Program Element (Number/Name) PE 0602105A / *Materials Technology*				Project (Number/Name) H7G / *Nanomaterials Applied Research*				
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
H7G: *Nanomaterials Applied Research*	-	3.321	3.107	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	6.428

Note

Project ended in FY18.

A. Mission Description and Budget Item Justification

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

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

Work in this project builds on the materials research transitioned from PE 0601104A. This work complements and is fully coordinated with PE 0602618A (Ballistics Technology), PE 0602786A (Warfighter Technology), and PE 0603001A (Warfighter Advanced Technology).

The cited work is consistent with the S&T priorities of the U.S. Army Chief of Staff, Assistant Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Nanomaterials Applied Research	3.321	-	-
Description: Devise and validate improved physics-based, materials property models and concepts for multifunctional, lightweight, and responsive materials. Exploit breakthroughs in nanomaterials and multifunctional fiber processing technologies, such as scale-up of processes and fabrication into woven materials, to enable revolutionary future Soldier capabilities.			
Title: Emerging Materials for Soldier Protection	-	3.107	-
Description: Identify, exploit, scale-up, and accelerate the transition of promising breakthroughs in materials research, including nanomaterials, biotechnology, multifunctional materials, and processing science research, via collaborative government, academia, and industry to deliver new materials technologies that revolutionize soldier capabilities and enable expeditionary operations.			
FY 2018 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** H7G / *Nanomaterials Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Investigate and down-select promising materials technologies, and fund research focused on achieving protection materials that enable a 20% reduction in weight relative to current systems. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Research ends in FY18.			
Accomplishments/Planned Programs Subtotals	3.321	3.107	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602105A / *Materials Technology*	Project (Number/Name) H84 / *Materials*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H84: *Materials*	-	27.629	26.533	24.100	-	24.100	23.823	25.672	27.079	28.613	0.000	183.449

A. Mission Description and Budget Item Justification

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

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

Work in this Project makes extensive use of high performance computing and experimental validation and builds on research transitioned from Program Element (PE) 0601102A (Defense Research Sciences), project H42 (Materials and Mechanics), and project H43 (Ballistics). The work complements and is fully coordinated with efforts in PE 0602105A (Materials Technology), PE 0602601A (Combat Vehicle and Automotive Technology), PE 0602618A (Survivability and Lethality Technologies), PE 0602786A (Warfighter Technology), PE 0603001A (Warfighter Advanced Technology), PE 0603004A (Weapons and Munitions Advanced Technology), PE 0603005A (Combat Vehicle Advanced Technology), and PE 0708045A (Manufacturing Technology).

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Structural Armor Materials	5.300	3.996	3.953
Description: Conduct applied research to design and evaluate lightweight armor materialsand structures, investigate novel processing methodologies for cost effective manufacturing, use existing and emerging modeling and simulation tools to enable formulation of lightweight, frontal, and structural armor materials for current and future platform applications. Explore ground vehicle structural mechanics and dynamics technologies to improve damage tolerance, durability, fatigue-resistance, and dynamic response (shock, vibration, harshness, and damping).			
FY 2018 Plans: Establish new processing science to produce transparent composites using material composition to control and optimize ballistic performance; further mature new methods to modify surfaces and interfaces in composite and nanocomposite systems and produce small scale bulk composites with enhanced structural and ballistic materials.			
FY 2019 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** H84 / *Materials*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Will investigate new magnesium alloy compositions that offer improved, lightweight ballistic resistance using first principles methods and techniques; will assess the causes of delayed cracking in high hardness armor steel by performing stress corrosion cracking characterization on a statistically significant number of armor plates. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reducing investment as methods to modify surfaces and interfaces in composite and nanocomposite systems has matured.			
Title: Soldier-Borne Armor Materials ***Description:*** Utilizing understanding of defeat mechanisms from PE 0602618A/project H80, conduct applied research of emerging lightweight armor materials and structures to enable affordable design of multifunctional ballistic protective systems for the future Soldier. Provide quantitative scientific basis for modeling and simulation that result in materials that utilize new lethal mechanisms/protection schemes for the individual Warfighter. ***FY 2018 Plans:*** Explore synthetic scale-up for potential protection system design application; using computational models, produce and characterize unidirectional laminates; using validation results of multiscale models, adjust models to improve accuracy of deformation and failure predictions. ***FY 2019 Plans:*** Will demonstrate efficient and complete synthesis of boron suboxide (B6O) armor ceramics, quantify effects of powder morphology, size and size distribution, and characterize the critical mechanical properties versus reactive hot pressing process conditions; develop processing pathways to fabricate armor ceramic with novel multiscale heterogeneity and characterize ballistic performance. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduction in modeling efforts to support acceleration of Synthetic Training Environmental senior leader priorities.	6.754	7.042	4.927
Title: Lethality Materials Technology ***Description:*** This effort involves applied research to develop innovative materials solutions aimed at achieving leap-ahead increases in lethality and weapons effectiveness through dramatic improvements in weight and volume efficiency, lethal effects, and sustainability of military systems that can only be achieved through advances in materials technology. ***FY 2018 Plans:*** Validate iron based alloy and characterize integrity through a lethality application demonstration; produce prototype high energy density polymeric materials and demonstrate their capability as energetic binders. ***FY 2019 Plans:***	4.400	3.738	3.818

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** H84 / *Materials*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Will finalize alloy selection and process development of novel, non-cobalt containing, binders for tungsten carbide based armor piercing projectiles; will utilize atmospheric plasma chemical vapor deposition to synthesize films of metastable material phases for use in energetics applications. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased investments to support CSA priorities of Soldier Lethality.			
Title: Multifunctional Armor Materials ***Description:*** This effort researches novel multifunctional armor materials and associated processing science aimed at enabling critical Army applications in survivability and sustainment. Research efforts include multifunctional protective films and coatings, joining of dissimilar materials, and additive manufacturing of multifunctional materials. Soldier personnel protection materials transition to PE 0602786A/project H98. Vehicle armor materials transition to PE 0602618A/project H80 and PE 0602601A/project C05 ***FY 2018 Plans:*** Use newly enhanced computational capabilities that link additive manufacturing processes to desired structure and properties to produce small scale material; identify specific electromagnetic processes to control specific microstructures to produce materials with optimized microstructures and desired properties using low temperature, low pressure electromagnetic processes; use modeling tools to further design and mature ceramics exhibiting desired, predicted structures and properties. ***FY 2019 Plans:*** Will apply multi-objective topological optimization algorithms to develop multi-functional design in critical components to address lightweighting goals; will develop stimuli-responsive methods to change material stiffness using low power mechanisms that also provide faster response times; will develop three-dimensional phase diagrams that incorporate magnetic field influence over phase formation by visualizing temperature-composition-field relationships; and will develop metamaterial structures that can be reconfigured rapidly and with spatial complexity to re-direct load paths or enhance energy absorption in real time. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Due to the level of maturity of this research, the investments in multifunctional armor was decreased to support advanced materials with capabilities to respond and adapt to a wide range of external stimuli.	9.200	9.697	6.143
Title: Nanomaterials ***Description:*** Mature and scale-up nanomaterials processes, fabrication, characterization and performance measures to enable revolutionary concepts for future force lethality and survivability beyond those addressed for individual Soldier protection in PE 062105A (Materials Technology) / Project H7G (Nanomaterials Applied Research). ***FY 2018 Plans:***	1.975	2.060	2.072

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602105A / *Materials Technology*	**Project (Number/Name)** H84 / *Materials*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Produce bulk material for active/adaptive armor and/or weapon material from newly developed hybrid, multifunctional polymer coatings, composites, and films with enhanced dielectric and electromagnetic properties. ***FY 2019 Plans:*** Will develop scalable mechanical alloying methods for nanocrystalline copper-tantalum (Cu-Ta) with parametric variation of phase chemistry, sintering time, temperature, texture evolution, grain size refinement, and secondary phase formation/distribution; will investigate the processing of aluminum alloys with novel chemistries for the generation of hydrogen through nano-galvanic cell formation. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding increase due to inflation.			
Title: Bio-enabled Materials and Processes ***Description:*** Fundamental research through the application of biotechnology advances to develop materials with capabilities to respond and adapt to a wide range of external stimuli and biological processes. ***FY 2019 Plans:*** Will conduct rapid design, selection and production of peptide reagents for potential applications such as the improvement of sensor devices, and logistics and sustainment; and will design and develop specialty materials via synthetic biology for potential applications that will improve safety, cost, logistics, robustness, and create new abilities to adapt existing materiel. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** New effort to support CSA priorities for Soldier Lethality.	-	-	3.187
Accomplishments/Planned Programs Subtotals	27.629	26.533	24.100

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602105A / *Materials Technology*	Project (Number/Name) XW4 / *Manufacturing Science*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
XW4: *Manufacturing Science*	-	0.000	0.000	4.500	-	4.500	5.000	5.596	5.938	6.281	0.000	27.315

Note

This is a new start for FY19.

A. Mission Description and Budget Item Justification

This Project links materials research, manufacturing processes, and design to enable rapid development and certification of lightweight, multifunctional materials technologies for protection, maneuver, and situational awareness. Research conducted enables new manufacturing capabilities through the development of high performance feedstock materials (polymers, metals, ceramics), physics-based process models, and in situ process monitoring that can be integrated with process models to enable real-time control and manipulation of materials structure and properties. The goal of this work is to develop robust predictive model and simulation tools linking manufacturing processes with materials structure, properties, and performance to accelerate the rate of innovative material adaptations (protection, power, sensing, signature management) necessary to rapidly respond to emerging and unknown threats in a battlefield environment.

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

Work in this Project makes extensive use of high performance computing and experimental validation and builds on research transitioned from Program Element (PE) 0601102A (Defense Research Sciences), Project H42 (Materials and Mechanics), and Project H43 (Ballistics). The work complements and is fully coordinated with efforts in PE 0602105A (Materials Technology), PE 0602601A (Combat Vehicle and Automotive Technology), PE 0602618A (Survivability and Lethality Technologies), PE 0602786A (Warfighter Technology), PE 0603001A (Warfighter Advanced Technology), PE 0603004A (Weapons and Munitions Advanced Technology), PE 0603005A (Combat Vehicle Advanced Technology), and PE 0708045A (Manufacturing Technology).

The cited work is consistent with the S&T priorities of the U.S. Army Chief of Staff, Assistant Secretary of Defense for Research and Engineering science and technology priority focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Agile Expedient Manufacturing	-	-	4.500
Description: Conduct applied research to develop innovative materials technologies that enable new protection, power, sensing, and signature management capabilities utilizing additive manufacturing and related methods to rapidly respond to emerging and unknown threats in a battlefield environment. Efforts include the development of new feedstock materials, engineered specifically for low-volume additive processes to produce net-shape materials with desired properties and functionalities, new processing capabilities that revolutionize additive manufacturing and enable production of lightweight materials systems for protection and maneuverability that cannot be produced through traditional manufacturing methods, integrated process models and real-time			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602105A / *Materials Technology*	Project (Number/Name) XW4 / *Manufacturing Science*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
monitoring for closed-loop control and optimal production of lightweight materials, and abilities to design and produce optimal materials at the point of need using available materials, energy sources, etc. ***FY 2019 Plans:*** Will quantify processing-structure-property relationships in additively manufactured steel alloys; validate continuum scale finite element-based model of laser-metal powder bed additive manufacturing process and mesoscale phase field model of microstructure prediction. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort supports the acceleration of the quantification and validation effort of additively manufactured steel alloys.			
Accomplishments/Planned Programs Subtotals	-	-	4.500

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602120A / *Sensors & Electronic Survivability*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	50.574	35.730	32.366	-	32.366	31.106	32.339	32.858	33.515	0.000	248.488
H16: *S3I Technology*	-	19.589	16.890	19.423	-	19.423	17.031	18.640	19.021	19.401	0.000	129.995
SA1: *Sensors and Electronic Initiatives (CA)*	-	15.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	15.000
SA2: *Biotechnology Applied Research*	-	1.327	1.683	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.010
TS1: *Tactical Space Research*	-	6.482	7.032	3.498	-	3.498	4.444	3.875	3.812	3.888	0.000	33.031
TS2: *Robotics Technology*	-	8.176	10.125	9.445	-	9.445	9.631	9.824	10.025	10.226	0.000	67.452

A. Mission Description and Budget Item Justification

This Program Element (PE) investigates designs and evaluates sensors and electronic components and software that enhance situational awareness, survivability, lethality, and autonomous mobility for tactical ground forces. Project H15 focuses on Combat Identification (CID) technologies, which include devices to locate, identify, track, and engage targets in the Joint fires environment. Project H16 investigates sensors, signal processing and information fusion technologies to increase target detection range and speed of engagement. Project SA1 (Congressional Interest Item) focuses on the design and development of Assured Positioning, Navigation, and Timing, and Robust Communications technologies for the Warfighter in disadvantaged/degraded environments. Project SA2 conducts applied research on biological sensors and biologically derived electronics that exploits breakthroughs in biotechnology basic research in collaboration with the Institute for Collaborative Biotechnology (ICB), a University Affiliated Research Center (UARC) led by the University of California, Santa Barbara in partnership with California Institute of Technology and Massachusetts Institute of Technology and their industry partners. Project TS1 researches and evaluates space-based remote sensing, signal, and information processing software in collaboration with other Department of Defense (DoD) and government agencies to support space force enhancement and space superiority advanced technology integration into Army battlefield operating systems. Project TS2 focuses on advancing perception for autonomous ground mobility, intelligent vehicle control and behaviors, human-robot interaction, robotic manipulation, and unique mobility for unmanned vehicles.

Work in this PE complements and is fully coordinated with efforts in PE 0602307A (Advanced Weapons Technology), PE 0602705A (Electronics and Electronic Devices), PE 0602709A (Night Vision Technology), PE 0602782A (Command, Control, Communications Technology), PE 0603001A (Warfighter Advanced Technology), PE 0603006A (Command, Control, Communications Advanced Technology), PE 0603008A (Command Electronic Warfare Advanced Technology), PE 0603710A (Night Vision Advanced Technologies), and PE 0603772A (Advanced Tactical Computer Science and Sensor Technology),

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

Work in this PE is performed by the Army Research Development and Engineering Command (RDECOM)

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army	Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602120A *I Sensors & Electronic Survivability*

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	36.109	35.730	29.882	-	29.882
Current President's Budget	50.574	35.730	32.366	-	32.366
Total Adjustments	14.465	0.000	2.484	-	2.484
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	15.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.529	-			
• Adjustments to Budget Years	-	-	2.484	-	2.484
• FFRDC	-0.006	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: SA1: *Sensors and Electronic Initiatives (CA)*		
Congressional Add: *Program Increase*	5.000	-
Congressional Add: *Space and Small Satellites Technologies Demonstration*	7.000	-
Congressional Add: *Signals Detection Research*	3.000	-
Congressional Add Subtotals for Project: SA1	15.000	-
Congressional Add Totals for all Projects	15.000	-

Change Summary Explanation

FY17 Congressional increase in SA1 Sensors and Electronic Survivability

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / *Sensors & Electronic Survivability*	Project (Number/Name) H16 / *S3I Technology*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H16: *S3I Technology*	-	19.589	16.890	19.423	-	19.423	17.031	18.640	19.021	19.401	0.000	129.995

A. Mission Description and Budget Item Justification

This Project designs, investigates, evaluates, and characterizes advanced sensor components, signal processing, and information fusion algorithms that will provide the future Soldier decisive new capabilities to locate, identify, and make decisions about and engage battlefield targets in tactical environments. The ultimate impact and utility of this work will be to greatly increase the lethality, range, and speed of engagement of the Soldier. Emphasis is on solving critical Army-specific battlefield sensing and information management problems, such as false targets, complex terrain (including urban applications), movement of sensors on military vehicles, and exploitation of multimodal sensors. Significant areas of research include low-cost networked sensors for force protection, hostile fire defeat, homeland defense, counter terrorism operations, munitions, and fusion of disparate sensors (e.g., acoustic, seismic, electric-field (E-field), magnetic field) to passively detect, classify, and track battlefield targets such as personnel, heavy/light vehicles, and helicopters. Other areas of research include sensing technologies for tagging, tracking, and locating (TTL) non-traditional targets and the location of direct and indirect fires and other hostile threats. Further areas of research include ultraviolet (UV) optoelectronics for battlefield sensors, networked compact radar for vehicle and dismount identification and tracking; ultra-wideband radar for buried and concealed threat detection, enhanced robotic mobility, stand-off characterization of infrastructure, and the detection, classification, and tracking of humans in urban terrain. Additional areas of research are aided/ automatic target recognition (ATR), advanced battlefield sensor and information processing to conduct a dynamic and real time situational assessment to present a common picture of the battle space focused on low echelon commanders; protection of sensors, especially human eyes, from battlefield laser threats; and advanced computational methods to provide automatic information technologies from widely dispersed sensor and legacy information sources for improved situational awareness.

This Project supports Army Science and Technology efforts in the Command Control and Communications, Ground, and Soldier portfolios. The sensor-related work in this Project complements efforts funded in Program Element (PE) 0601104A (University and Industry Research Centers), PE 0602709A (Night Vision Technology), PE 0603710A (Night Vision Advanced Technologies), and PE 0603001A (Warfighter Advanced Technology). The networked sensing and data fusion efforts performed in this Project complement efforts funded in PE 0601104A / Project H50 (Network Sciences CTA) and PE 0601104A / Project J15 (Network Science and Technology Research Center International Technology Alliance).

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Non-Imaging Intelligence, Surveillance, and Reconnaissance (ISR) Sensing	4.675	6.014	6.169
Description: This effort designs and characterizes technologies for multi-modal (acoustic, seismic, infrasound, electric and magnetic (E/H) field, and passive radio frequency (RF)), low-cost networked sensors to enhance persistent sensing capabilities for increased probability of target detection and reduced false alarms. These combined sensors have unique capabilities that enable detection of electrical equipment operation, underground facilities, vehicles, weapons launch, gunfire, and explosions.			
FY 2018 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors & Electronic Survivability*	**Project (Number/Name)** H16 / *S3I Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Improve acoustic and infrasound sensors and algorithms for detection, localization, tracking, and classification of air and ground platforms and transient weapon/explosive events; research geophysical/seismological sensing methods; develop infrasound propagation data analysis, and a corresponding modeling/simulation capability; develop acoustic techniques for locating of surface and subsurface events; investigate and E/H fields from power-lines, electrical equipment, and Earth; develop improved E/H-field sensors and algorithms; improve size, weight, power and cost (SWaP-C) of monitoring nodes; provide persistent Intelligence, Surveillance, and Reconnaissance (ISR) and decision support capabilities to lower Army command echelons; improve networked sensor coverage and probability of detection and false alarm rate with distributed processing and fusion techniques; support information sharing and decision making and improve information density of sensor data streams; improve Special Operations Command (SOCOM) mobility by developing (1) faster, quieter and more accurate Landing Zone assessment techniques with minimal over-watch and (2) a streamlined method of data input and analysis; and characterize and assess technologies and sensor modalities that can detect and identify improvised explosive device systems and components that are buried or non-buried. ***FY 2019 Plans:*** Will develop robust, low-cost acoustic sensors with 1 to 10000 Hz frequency response to detect and locate Army-relevant target signals in environments of interest; will focus on sensor miniaturization and small arrays; will develop novel wind noise reduction techniques that are necessary for successful particle-velocity sensor operation in complex military scenarios and on mobile platforms; will develop new tools to calibrate and characterize quasi-static E/H field sensors for long-wavelength applications, such as power-line sensing, anomaly detection, and low-frequency positioning/navigation/timing; will develop novel detection, classification, and identification algorithms for new classes of targets; will characterize and assess technologies and sensing modalities that can detect and identify improvised explosive threats, detect their components, and mitigate their delivery platforms; and will develop and integrate automated multi-modal detection, tracking, classification and decision support tools for deployment on low resource tactical platforms, ground stations and sensors. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased funding to develop multi-modal detection and tracking capabilities			
Title: Networked Sensing and Data Fusion	5.496	5.137	4.633
Description: This effort will develop and assess a concept to link physical sensors and information sources to Soldiers and small units. Specifically, the research focuses on (1) multi-modal sensor fusion for detection and classification of human activities and infrastructures such as personnel, vehicles, machinery, radio frequency (RF) emissions, chemicals, and computers in hidden and confined spaces, (2) interoperability and networking of disparate sensors and information sources, (3) distributed information for decision-making, and (4) approaches for fusing results of processed outputs of multi-modal sensors, such as visible, infrared (IR), and hyperspectral imagers, and acoustic, magnetic, and electric field sensors. ***FY 2018 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors & Electronic Survivability*	**Project (Number/Name)** H16 / *S3I Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Develop distributed processing and fusion algorithms that use shared decision-making processes over low-power, short-lifetime sensors with limited communication capabilities for efficient battlefield situational awareness to the dismounted Soldier; develop sensor interoperability/integration standards to enable rapid cueing of coalition imaging and acoustic sensors for robust target classification; develop robust methods to detect, classify, and track humans using networked, multi-modal sensing and fusion as an alternative replacement to anti-personnel landmines; develop tools for creating and visualizing a multi-sensor three-dimensional (3D) common operating picture (COP) capable of performing real-time data geo-registration and fusion from multiple aerial and ground-based passive and active imaging sensors for increased situational awareness; and develop tools for biometric and human activity recognition from video feeds. ***FY 2019 Plans:*** Will develop focused infrasonic classification methods and integrate them with long-range sound propagation models to increase classification accuracy; will develop algorithms to provide automated tipping and cueing at each sensor array for incorporation into the analyst?s common operating picture; will develop tools for creating and visualizing a multi-sensor 3D common operating picture for real-time data geo-registration and fusion of heterogeneous data from multiple aerial and ground-based passive and active imaging sensors for increased situational awareness; will develop tools for multimodal biometrics and human activity recognition using unconstrained video; will explore scene representation models for optimized, real time implementation; will develop theory for inference and subjective networks that benchmark performance against other uncertain reasoning methods; will develop higher level fusion of event tracking from sensor and social media data in uncertain environments via subjective logic Bayesian networks; and will develop robust capability for communications, sensors and data management and information fusion for a large network of ground sensors. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decreased funding due to maturity of signal processing algorithms to support multi-mode air defense radar			
Title: RF Sensing for Concealed/Low-Signature Threat Detection (previously Ultra Wideband (UWB) Radar) ***Description:*** This effort develops the technical underpinnings of ultra-wideband (UWB) radar and other active and passive radio frequency (RF) sensing modalities for several key Army concealed and low-signature target detection requirements, including landmine and improvised explosive device (IED) detection, sensing through-the-wall, foliage penetration, unmanned aerial system (UAS) detection, other electronic threat detection, and obstacle avoidance for autonomous navigation. This research uses a combination of advanced computational electromagnetic models and algorithms, radar measurements, active and passive RF sensing technologies, and advanced signal processing techniques to define the performance boundaries of state-of-the-art airborne and ground-based UWB radar and other RF sensing modalities for concealed and low-signature target detection and classification. ***FY 2018 Plans:***	1.794	2.713	2.967

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors & Electronic Survivability*	**Project (Number/Name)** H16 / *S3I Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Incorporate passive RF sensing modality with UWB radar to improve detection of electronic targets (e.g., radio controlled triggers); assess performance of combined forward-looking sensors against relevant threat; develop a lightweight UAS-compatible RF sensor with equivalent sensitivity to a vehicle-mounted stepped frequency radar in order to increase standoff protection beyond the blast radius; investigate an adaptive and learning (i.e., cognitive) electronic front-end that can be incorporated with a UWB radar that will improve operations in congested and contested RF environments; and utilize low-cost software-defined radio (SDR) technology and 2D antenna arrays to detect, geo-locate, and track aerial- and ground-based electronic threats. ***FY 2019 Plans:*** Will reduce sensor size with on-board signal processing for automated detection and tracking; will investigate the benefits of cooperative RF sensing in complex environments; and will assess the processing constraints introduced by distributed sensing. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased funding to shift program focus towards distributed sensing			
Title: Laser Protection Technologies (previously Networked Compact Radar, Wide Bandgap Optoelectronics, and Laser Protection Technologies) ***Description:*** This effort develops new materials and devices for the protection of Army sensors and eyes behind day-view optical sights from a variety of laser threats including high-power continuous wave and ultrashort (femto-second) pulsed lasers. This research utilizes a combination of technologies based on the nature of the different threats, as well as the fundamental differences in sensors operating over different frequency ranges. Passive organic and inorganic optical limiter materials that block specific frequency bands of light will be investigated and developed for the visible and short-wave infrared (SWIR) spectrum, and active man-made material-based solutions will be investigated for uncooled sensors in the long-wave IR (LWIR). Vulnerability of sensors and optical sensor systems will be studied against high-power and ultrashort pulsed laser threats to determine protection requirements. ***FY 2018 Plans:*** Investigate the use of short-pulsed (femto-second) optical limiting materials to prevent sensor damage, and determine if some of the secondary destructive effects of these types of pulses can be mitigated; develop and test solid material limiters for nanosecond to microsecond threats and compare their performance to liquid material limiters; and explore advanced concepts to protect optical systems, both visible and infrared (IR) high-power continuous wave lasers. ***FY 2019 Plans:*** Will improve multi-chromophore solid-state optical limiter based on previous experimental results; will investigate femtosecond limiter concepts in the mid-wave infrared; and will conduct experiments to validate high power continuous wave laser protection	3.757	2.957	5.154

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors & Electronic Survivability*	**Project (Number/Name)** H16 / *S3I Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
concepts. These combined efforts will enable transmission of low light intensities, while blocking laser radiation with excessively high irradiance hence preventing sensor damage. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased funding in laser protection technologies to develop limiter solutions for reducing light transmission intensities			
Title: Multi-Mode Air Defense Radar ***Description:*** This research supports the current and future technical challenges associated with air defense radar technology. In particular, this effort will analyze current and emerging radio frequency (RF) spoofing, RF jamming, and RF signature management technologies to determine their impact on the performance of air defense radars. Electromagnetic modeling, RF measurements, and experiments will be used to identify mitigation techniques for spoofing and jamming, and to identify useful signature management technologies. This will also include research in electronic devices, sub-assembly design, and laboratory experiments to advance the state-of-the-art of air defense radars operating in contested electronic environments. ***FY 2018 Plans:*** Finalize and document electromagnetic modeling results, advanced circuit designs, and cognitive algorithm development work. ***FY 2019 Plans:*** Will adapt front end RF technologies for next generation fires radars. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased investments to enable development of scalable, multi-band RF components that can survive congested spectral environments	3.867	0.069	0.500
Accomplishments/Planned Programs Subtotals	19.589	16.890	19.423

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / *Sensors & Electronic Survivability*	Project (Number/Name) SA1 / *Sensors and Electronic Initiatives (CA)*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
SA1: *Sensors and Electronic Initiatives (CA)*	-	15.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	15.000

Note

Congressional Increase for FY17

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Sensors and Electronic Initiatives.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Program Increase ***FY 2017 Accomplishments:*** N/A	5.000	-
Congressional Add: Space and Small Satellites Technologies Demonstration ***FY 2017 Accomplishments:*** N/A	7.000	-
Congressional Add: Signals Detection Research ***FY 2017 Accomplishments:*** N/A	3.000	-
Congressional Adds Subtotals	15.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / *Sensors & Electronic Survivability*	Project (Number/Name) SA2 / *Biotechnology Applied Research*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
SA2: *Biotechnology Applied Research*	-	1.327	1.683	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.010

Note

This project ends in FY18.

A. Mission Description and Budget Item Justification

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Biotechnology Applied Research	1.327	1.683	-
Description: This effort exploits breakthroughs in biotechnology basic research accomplished at the ICB UARC to enable new capabilities in sensors, electronics, photonics, and network science.			
FY 2018 Plans: Integrate microbial communities for the conversion of waste and indigenous feedstocks or simulants to chemicals useful for waste-to-energy systems and starting materials for agile materials synthesis; integrate biological and non-biological components to convert waste and indigenous feedstocks to chemicals potentially useful for bio-hybrid fuel cells, and evaluate them for transition to waste-to-energy / alternative energy development programs; and investigate components of a high-throughput platform for on-demand assay development for robust biosensor reagents. Effort completes in FY 2018 and transitions to an Army Research, Development and Engineering Center (RDEC) partner to mature this research.			
FY 2018 to FY 2019 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors & Electronic Survivability*	**Project (Number/Name)** SA2 / *Biotechnology Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Project ends and transitions in FY18			
Accomplishments/Planned Programs Subtotals	1.327	1.683	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / *Sensors & Electronic Survivability*	Project (Number/Name) TS1 / *Tactical Space Research*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
TS1: *Tactical Space Research*	-	6.482	7.032	3.498	-	3.498	4.444	3.875	3.812	3.888	0.000	33.031

A. Mission Description and Budget Item Justification

This Project researches, evaluates, and adapts technologies for space-based and high altitude applications for Army tactical ground forces. Applied research efforts include the design and development of sensors and electronic components for communications, signal and information processing, target acquisition, position/ navigation, and threat warning within space and high altitude environments. The applied research and technology evaluations conducted under this Project leverage other Department of Defense (DoD) space science and technology applications to support Army space force enhancement and cooperative satellite payload development.

Work in this Project complements and is fully coordinated with Program Element (PE) 0603006A (Space Applications Technology).

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Tactical Space Research	5.444	5.916	2.371
Description: This effort designs, develops, and evaluates space-based technologies, components, and tools that lead to smaller, lighter, more responsive payloads and applications. These technologies allow for the rapid integration and development of tactical payloads in support of responsive space environments. Work related to standard Army networks is done in coordination with the Communications-Electronics Research Development and Engineering Center (CERDEC) and Army Cyber Center of Excellence.			
FY 2018 Plans: Design and develop small satellite components to support the Army?s multi-band beyond-line-of-sight (BLOS) and on-the-move communications for disadvantaged users; refine data processing algorithms and define network integration interfaces to improve Army tracking and locating capabilities for ground objects of interest; initial accreditation of network used to verify satellite command and control capabilities and conduct experiments with orbit demonstration satellites, as well as incremental advances in capabilities to incorporate additional science and technology (S&T) satellite technology efforts; and continue to monitor collaboration opportunities with other Services and Agencies on small satellite and affordable launch capabilities.			
FY 2019 Plans: Will refine tag, track and locate capabilities for ground objects of interest, advance space-based data exploitation technologies and components, space-based signal detection/processing/dissemination technologies, and software algorithms to enable cohesive exploitation from single or multiple small satellite platforms. Will design and refine small satellite/payload components focused on			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors & Electronic Survivability*	**Project (Number/Name)** TS1 / *Tactical Space Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
the improvement of warfighter tag, track, and location capabilities to include planning for tasking, processing, exploitation, and dissemination. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** In FY 2019, funds from this effort are realigned to support the Army Modernization Priorities.			
Title: Space and Analysis Lab ***Description:*** This effort provides an in-house capability to design and conduct analytic evaluations of space and high altitude technologies. ***FY 2018 Plans:*** Complete the development of experimental small satellite payloads and prepare for integration on flight vehicle; and validate capabilities through the use of in-house distributed bench assessment and Hardware In The Loop capabilities. ***FY 2019 Plans:*** Will develop in-house research capabilities for small satellite/payload and component design, development and validation for tactical spacecraft; and will assess new technologies for spacecraft components. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding increased due to inflation.	1.038	1.116	1.127
Accomplishments/Planned Programs Subtotals	6.482	7.032	3.498

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602120A / *Sensors & Electronic Survivability*	Project (Number/Name) TS2 / *Robotics Technology*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
TS2: *Robotics Technology*	-	8.176	10.125	9.445	-	9.445	9.631	9.824	10.025	10.226	0.000	67.452

A. Mission Description and Budget Item Justification

This Project designs, evaluates, and investigates autonomous technologies to enable robotics to assist military missions. Technical efforts are focused on advancing perception for autonomous ground and air mobility, intelligent vehicle control and behaviors, human-robot interaction, robotic manipulation, and improved mobility for unmanned vehicles of scales from micro-systems through tactical combat vehicles. The Project provides the underpinning research of the Robotics Collaborative Technology Alliance (CTA), a cooperative arrangement with industry and academia to conduct a concerted, collaborative effort advancing key enabling robotic technologies required for future unmanned systems. The Robotics CTA research is funded in Program Element (PE) 0601104A/Project H09.

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

This Project leverages basic research conducted under PE 0601102A/Project T63 (Robotics Autonomy, Manipulation and Portability) and PE 0601104A/Project H09 (Robotics CTA) and transitions knowledge and emerging technologies to PE 0603005A (Combat Vehicle and Automotive Advanced Technology) for maturation and demonstration.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology focus areas, and the Army Modernization Strategy. The Ground Portfolio technology investments are improving logistics throughput and surge capability supporting maneuver forces (Leader-Follower technology) and allow experimentation with manned and unmanned teams to develop the advantages that inform/protect the maneuver force..

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Robotics CTA	3.540	4.023	3.317
Description: Conduct applied research to provide essential capabilities for advanced perception, intelligent control and tactical behavior, human-robot interaction, robotic manipulation, and unique mobility for unmanned systems to conduct multiple military missions for a full range of robots from man-portable to larger systems. Research focuses on new sensor and sensor processing algorithms for rapid detection and classification of objects in cluttered and unknown environments, enabling autonomous mobility and intelligent tactical behavior by future unmanned systems; implementing adaptive control strategies that will enable unmanned systems to display intelligent tactical behavior, formulation of control strategies that will facilitate use of unmanned systems in populated environments and minimize the cognitive workload on Soldier operators enabling more dexterous manipulation of objects.			
FY 2018 Plans: Instantiate full capability for an unmanned ground robot Talon and below size) to conduct a simplified, yet realistic military mission at less than human operational speed, including perceptual, mobility, and manipulation capabilities. Planning on near-field			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors & Electronic Survivability*	**Project (Number/Name)** TS2 / *Robotics Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
recognizance to demo technology with applicability to multiple Research, Development and Engineering Center (RDEC) demos for ground platforms (e.g, convoy operations, tactical logistics, Intelligence, Surveillance, and Reconnaissance (ISR)). Conduct a performance assessment with the aim of transition to concept demonstrations conducted by an Army Research, Development and Engineering Center (RDEC). ***FY 2019 Plans:*** Will demonstrate cognitive architecture with the integrated capabilities of perception, intelligent control and tactical behavior, human-robot interaction, robotic manipulation, and unique mobility. A limbed robot employing dynamic locomotion solely through electromotive rotary actuators will be assessed with the Robotics collaborative technology alliance (CTA) cognitive architecture for autonomous capability. Perception and intelligence for a dynamic limbed platform will be demonstrated to show its capacity for teaming in an optempo scenario. Whole body manipulation will be employed in conjunction with the cognitive architecture to demonstrate the ability to perform environment interactions autonomously in ad hoc scenarios. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funds realigned to higher priority areas.			
Title: Perception and Intelligent Control ***Description:*** Advance perception and intelligent control technologies required to achieve autonomous tactical behaviors, based on the environment, and other objective capabilities for future unmanned vehicles of multiple size scales and to transition this technology to advanced development programs being conducted under PE 0603005A (Combat Vehicle and Automotive Advanced Technology)/Project 515 (Robotic Ground Systems) for integration into test bed systems. ***FY 2018 Plans:*** Expand the perceptual, reasoning, and learning capabilities into a comprehensive architecture and conducting experimentation. Utilize a cognitive construct for abstract reasoning to more effectively integrate individual perceptual algorithms together with contextual information. ***FY 2019 Plans:*** Will integrate a map-based and an ontology focused World Model to provide a more complete architecture for reasoning and understanding the environment. Cognitive approaches to perception will be implemented on robotic platforms and methods for artificial intelligence assessment will be employed to ensure future unmanned systems can offer transparency in their cognitive processes. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY19 funding reduced due to less design time needed	4.636	4.640	4.662
Title: Ground Robotic Vehicle Mobility and Propulsion Technology	-	1.462	1.466

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602120A / *Sensors & Electronic Survivability*	**Project (Number/Name)** TS2 / *Robotics Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: Advance the speed and agility of unmanned vehicles in complex three-dimensional environments through exploration of advanced and unconventional mobility and propulsion technologies integrated with innovative application of perceptual and reasoning capabilities. Ground robotic platforms may have legs, may be able to climb or may even be robots restricted to small confined spaces. Research will focus on developing actuation mechanism that intelligently achieve movement while minimizing the use of energy to ensure longer range and endurance of the system. ***FY 2018 Plans:*** Explore hybrid modes of mobility to enable energy efficient mobility at operational tempo. ***FY 2019 Plans:*** Will explore novel mechanics and perception/proprioception technology to enable robust, resilient, and self-sustaining mobility of ground vehicle platforms. Research will be conducted in embedded and inherent sensing, actuation, control of complex structural dynamics, and cognitive/perceptual architectures. Embedded and inherent sensing will also be investigated as a technique to enable locally-controlled reflexive and intuitive behaviors. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase due to inflation.			
Accomplishments/Planned Programs Subtotals	8.176	10.125	9.445

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602122A / *Tractor Hip*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	6.995	8.627	8.674	-	8.674	9.319	9.467	9.619	9.812	0.000	62.513
622: *D622*	-	2.275	3.823	3.840	-	3.840	4.390	4.439	4.488	4.578	0.000	27.833
B72: *AB72*	-	4.720	4.804	4.834	-	4.834	4.929	5.028	5.131	5.234	0.000	34.680

Note

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

A. Mission Description and Budget Item Justification

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

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	6.995	8.627	8.674	-	8.674
Current President's Budget	6.995	8.627	8.674	-	8.674
Total Adjustments	0.000	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602122A / *Tractor Hip*				Project (Number/Name) 622 / *D622*			
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
622: *D622*	-	2.275	3.823	3.840	-	3.840	4.390	4.439	4.488	4.578	0.000	27.833

A. Mission Description and Budget Item Justification

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

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602122A / *Tractor Hip*				Project (Number/Name) B72 / *AB72*			
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
B72: *AB72*	-	4.720	4.804	4.834	-	4.834	4.929	5.028	5.131	5.234	0.000	34.680

A. Mission Description and Budget Item Justification

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602126A / *TRACTOR JACK*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	0.000	0.000	0.400	-	0.400	0.400	0.400	0.500	0.510	0.000	2.210
XW8: *TRACTOR JACK*	-	0.000	0.000	0.400	-	0.400	0.400	0.400	0.500	0.510	0.000	2.210

A. Mission Description and Budget Item Justification

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

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	0.000	0.000	0.000	-	0.000
Current President's Budget	0.000	0.000	0.400	-	0.400
Total Adjustments	0.000	0.000	0.400	-	0.400
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-	-			
• Adjustments to Budget Years	-	-	0.400	-	0.400

Change Summary Explanation

New FY19 classified project

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602211A / *Aviation Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	67.593	66.086	64.847	-	64.847	61.594	61.102	62.911	65.971	0.000	450.104
47A: *AERON & ACFT Wpns Tech*	-	54.082	55.630	53.884	-	53.884	50.413	49.622	51.195	54.021	0.000	368.847
47B: *Veh Prop & Struct Tech*	-	9.511	10.456	10.963	-	10.963	11.181	11.480	11.716	11.950	0.000	77.257
47C: *ROTORCRAFT COMPONENT TECHNOLOGIES (CA)*	-	4.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.000

A. Mission Description and Budget Item Justification

This Program Element (PE) conducts air vehicle component design, fabrication and evaluation to enable Army aviation transformation. Emphasis is on developing aviation platform technologies to enhance manned and unmanned air vehicle combat and combat support operations for attack, reconnaissance, air assault, survivability, logistics and command and control missions. Project 47A researches and evaluates components and subsystems for air vehicles in the areas of aviation and aircraft weapons technology. Project 47B researches and evaluates components and subsystems for air vehicles in the areas of propulsion and structures. Focus areas include: engines & drive trains; rotors & vehicle management systems; platform design & structures; aircraft & occupant survivability; aircraft weapons & sensors; maintainability & sustainability; and unmanned & optionally manned systems.

Work in this PE contributes to the Army Science and Technology (S&T) air systems portfolio and is fully coordinated with efforts in PE 0603003A (Aviation-Advanced Technology), PE 0602624A (Weapons and Munitions Technology), PE 0602303A (Missile Technology) and PE 0603710A (Night Vision Advanced Technology).

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering S&T focus areas and the Army Modernization Strategy. Work in this PE is performed by the Army Research, Development, and Engineering Command (RDECOM).

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army	Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602211A *I Aviation Technology*

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	65.914	66.086	61.846	-	61.846
Current President's Budget	67.593	66.086	64.847	-	64.847
Total Adjustments	1.679	0.000	3.001	-	3.001
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	4.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-2.292	-			
• Adjustments to Budget Years	-	-	3.001	-	3.001
• FFRDC	-0.029	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: 47C: *ROTORCRAFT COMPONENT TECHNOLOGIES (CA)*		
Congressional Add: *Congressional Program Increase*	4.000	-
Congressional Add Subtotals for Project: 47C	4.000	-
Congressional Add Totals for all Projects	4.000	-

Change Summary Explanation

FY17 Congressional increase in 47C Aviation Technology

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602211A / *Aviation Technology*	Project (Number/Name) 47A / *AERON & ACFT Wpns Tech*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
47A: *AERON & ACFT Wpns Tech*	-	54.082	55.630	53.884	-	53.884	50.413	49.622	51.195	54.021	0.000	368.847

A. Mission Description and Budget Item Justification

This Project designs and evaluates technologies for Army/Department of Defense (DoD) vertical lift and unmanned air systems to increase strategic and tactical mobility/deployability, improve combat effectiveness, increase aircraft and crew survivability; and improve combat sustainability. Areas of research address desired characteristics applicable to all aviation platforms, such as enhanced rotor efficiencies, improved survivability, increased structure and airframe capability, improved engine performance, improved sustainability, improved mission avionics performance, and reduced cost. This Project leverages work accomplished in collaboration with the National Aeronautics and Space Administration (NASA). Technologies within this project transition to advanced technology development programs with application to future, as well as current, Army/DoD aircraft systems.

Work in this Project is fully coordinated with Program Element (PE) 0603003A (Aviation Advanced Technology) and work in this Project related to aircraft weapons integration is also fully coordinated with PE 0602624A (Weapons and Munitions Technology), PE 0602303A (Missile Technology), and PE 0603710A (Night Vision Advanced Technology).

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: National Rotorcraft Technology Center (NRTC)	4.513	-	-
Description: NRTC focuses government, United States (U.S.) rotorcraft industry, and academia resources on the development of pre-competitive, high-priority, military technology to maintain U.S. preeminence in rotorcraft capabilities.			
Title: Platform Design & Structures Technologies	6.088	11.119	3.980
Description: Enables survivable, sustainable rotorcraft configurations by conceiving of and evaluating critical aviation technologies using design and analysis methods with greater modeling fidelity with an ultimate goal of reducing the timelines associated with overall design of new aircraft. Introduces high fidelity methodology for improved performance and design predictions earlier in the development and acquisition process. Use physics of failure modeling and coupled discipline analysis to drastically improve component and system reliability. Work is coordinated with Aviation Component Failure Modeling efforts in PE 0602211, Project 47B at Army Research Laboratory (ARL).			
FY 2018 Plans: Investigate and validate modeling and design tools to support development of future unmanned aerial vehicles. Conduct in-house and industry research in support of Next Generation Tactical Unmanned Aircraft Systems (NGTUAS) and other manned			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47A / *AERON & ACFT Wpns Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
and unmanned aircraft concepts; Develop a draft Model Performance Specification (MPS) for NGTUAS. Verify performance of multifunctional structures technologies for survivability through analysis and incremental testing; continue to mature probabilistic based stress and service life analyses; investigate advanced structural design and manufacturing techniques, including optimized smart structures and fastener-free joining methods. Initiate development of advanced damage tolerant electromechanical actuators to replace current generation hydraulic systems. Initiate development of energy optimized platform concepts and subsystems intended to maximize electric power availability while managing overall platform thermal loading and minimizing system level space, weight, and power burdens. ***FY 2019 Plans:*** Will conduct aircraft system conceptual design research of advanced manned and unmanned platforms. Will analyze and assess viability and potential performance of Next Generation Tactical UAS (NGTUAS) and other manned and unmanned system designs. Will conduct conceptual trade studies and analyses to refine the Model Performance Specification for NGTUAS. Will develop decision support tools to be incorporated into the integrated design environment to perform rapid trade space exploration and conduct technology and requirement sensitivity analyses. Will investigate conceptual design methodologies to assess uncertainty and reliability within the integrated design environment. Will further develop improved stress and load prediction capability that more accurately determines structural loads resulting from aerodynamic loads. Will explore biology-inspired, light-weight concepts that enable efficient, reliable, lighter weight platform structures. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decrease in funding from FY18 to FY19 as this applied research effort transitions to Advanced Development (6.3) for maturation and demonstration.			
Title: Rotors & Vehicle Management Technologies	10.395	10.832	11.089
Description: Design and investigate advanced airfoil and rotor blade technologies, including active control elements, to support goals of increased hover and cruise efficiency. Design and evaluate advanced flight control and vehicle management component technologies to support goals of increased maneuverability, reliability, and reduced weight and cost. ***FY 2018 Plans:*** Improve the accuracy and efficiency of high-fidelity computational fluid dynamics simulations on high-performance parallel computers including rotors and vehicles with active flaps, active flow control, and morphing surfaces; evaluate and optimize computational execution efficiency software on new heterogeneous parallel computer hardware architectures. Conduct sub-scale testing of an advanced rotor design; conduct benchtop and sub-scale testing of passive and active flow control concepts. Analyze Joint Multi-Role Technology Demonstration (JMR-TD) flight test data to assess and improve government simulation modeling methods for advanced configurations. Apply advanced control allocation methods to a piloted simulation based on a JMR TD configuration. Study flight control and handling-qualities issues associated with an advanced wing-compound configuration. ***FY 2019 Plans:***			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47A / *AERON & ACFT Wpns Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Will conduct investigation of winged-compound aeromechanics and technologies; will conduct fundamental computational and experimental investigation of rotor blade structural loads; will develop and improve flow measurement techniques such as infra-red thermography for flow transition measurement; will examine interactional aerodynamic effects on of multi-rotor configurations including the rotor downwash/outwash; will investigate advanced vertical lift aircraft configurations using both high-fidelity and mid/low fidelity computational methods; will validate computational aeromechanics models against wind tunnel and flight test data. Will investigate advanced hub and rotor concepts for high speed flight. Will explore technologies that enable high performance Unmanned Aerial Systems (UAS) rotors and propulsors. Will develop and release an integrated flight simulation modeling tool that transforms or stitches a few specific frequency-domain flight data points into a full-flight non-linear model. Will investigate an initial set of Unmanned Aerial Vehicle (UAV) handling qualities and UAV flight control design and test methods. Will conduct flight test research to: develop criteria for active inceptors; confirm techniques for improving measurements of rotor states for feedback to the flight control system; and new Mission Task Elements for high-speed configurations. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase in funding from FY18 to FY19 to explore technologies that enable Unmanned Aerial System (UAS).			
Title: Engine and Drives Technologies	6.364	6.664	7.551
Description: Design and evaluate advanced turboshaft engine component technologies to support goals of reduced fuel consumption, engine size, weight, and cost, as well as improved reliability and maintainability. Design and evaluate advanced drive system component technologies to support multi-speed transmissions, lighter weight gearboxes, and reduced costs, while improving reliability and maintainability ***FY 2018 Plans:*** Complete validation testing of smart, adaptable, and efficient sand filtration technology for improved engine performance and durability; complete investigation of alternative adaptable engine architectures in support of high performance alternative concept engine; investigate of alternative adaptable engine components in support of high performance alternative concept engine and Future Vertical Lift (FVL) objectives; continue validation through experimentation drive train component technologies with multi-speed (ability to vary shaft speed between 50 and 100%) in support of next generation rotorcraft transmission and FVL objectives. ***FY 2019 Plans:*** Will continue investigation of alternative adaptable engine components in support of the high performance alternative concept engine program and Future Vertical Lift/Future Tactical Unmanned Aerial Systems; initiate design of high reduction ratio component concepts to provide improved drive system horsepower to weight and life capability to Future Vertical Lift aircraft. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase in funding from FY18 to FY19 to meet Army priority of Future Vertical Lift (FVL) engines and drive trains.			
Title: Survivability For Degraded Visual Environment (DVE) Operations	9.149	8.500	0.500

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47A / *AERON & ACFT Wpns Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: Research advanced sensor and cockpit display technologies to provide ability to maintain terrain and obstacle situational awareness during aircraft induced (brown-out & white-out) and environmentally induced (rain, snow, smog, fog, smoke, low light, etc.) DVE. Work in this area is being done in coordination with efforts at Army CERDEC, PE 603710A, Night Vision Advanced Technology. ***FY 2018 Plans:*** Initiate MCLAWS Version 5 (V5) development; MCLAWS V5 will be the updated flight control laws for U.S. Army helicopters. Begin to incorporate laboratory modeling and reconfiguring of Obstacle Field Navigation (OFN) and Safe Landing Area Determination (SLAD) into MCLAWS V5. ***FY 2019 Plans:*** Will finalize Obstacle Field Navigation (OFN), Safe Landing Area Determination (SLAD) guidance that includes auto landing capability, and sensor driven guidance to enroute and multiple helicopter landing zone selection. Technologies in this area will transition to efforts in Army AMRDEC, PE 063003A, Survivability For Degraded Visual Environment (DVE) Operations. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decrease in funding from FY18 to FY19 as this applied research effort transitions to Advanced Development (6.3) for maturation and demonstration.			
Title: Aircraft and Occupant Survivability Technologies ***Description:*** Investigate advanced technologies to reduce susceptibility and vulnerability of aircraft to damage from threats or accidents, as well as technologies to defeat small arms, rocket and missile threats. ***FY 2018 Plans:*** Continue development of next generation advanced composite lightweight armor. Continue development of next generation lightweight ballistic tolerant crashworthy fuel containment systems. Continue development of crashworthiness subsystem devices that build on advanced crash protection concepts previously developed. Initiate development of advanced fire management subsystems. Continue development of adaptive Infrared (IR) engine suppressor system to optimize aircraft performance and Infrared (IR) signature. Continue to develop signature management technologies. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** This task has been realigned into Mission Systems to better coordinate survivability, offensive/defense weapons and sensors technologies	5.870	6.588	-
Title: Aircraft Weapon & Sensor Technologies	1.565	1.654	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47A / *AERON & ACFT Wpns Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: Design and develop innovative approaches for integrating advanced weapons and sensors on aircraft platforms, including smart dispensers, data transfer, and post-launch weapon communication. ***FY 2018 Plans:*** Define, develop and evaluate concepts for acquiring, storing, preparing, exploiting and distributing sensor data to enhance situational awareness, reduce crew workload and increase mission effectiveness. Refine the components required for launching organic payloads off of aircraft wingstores. Evaluate several air-to-air targeting algorithms intended to support advanced threat protection and counter Unmanned Aerial Systems (UAS). ***FY 2018 to FY 2019 Increase/Decrease Statement:*** This task has been realigned into Mission Systems to better coordinate survivability, offensive/defense weapons and sensors technologies			
Title: Mission Systems ***Description:*** Investigate technologies to reduce susceptibility and vulnerability of aircraft to damage from threats or accidents, as well as technologies to defeat small arms, rocket and missile threats. Investigate advanced engagement concepts of organically launch systems from Army aviation platforms. ***FY 2019 Plans:*** Will investigate adaptive Infrared (IR) engine suppression systems for future Army aircraft in an engine test cell to evaluate engine and IR suppression performance. Will continue maturation of signature management technologies for Future Vertical Lift (FVL). Will develop modeling and simulation tools to support survivability analysis against advanced threat systems. Will define, develop and assess advanced engagement concepts for exploitation of organically launch systems off of Army aviation platforms. Will investigate platform integration, mission systems, and survivability requirements to enable organically launch system engagements from Army aviation platforms. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** This is a new start for FY19.	-	-	11.894
Title: Unmanned and Optionally Manned Technologies ***Description:*** Design and Develop advanced Manned-Unmanned Teaming (MUM-T) concepts to expand aviation mission sets that include resupply, reconnaissance, surveillance, electronic warfare, protection, medical evacuation and attack. Design and develop collaborative and cooperative algorithms to support the goal of intelligent teaming for manned-unmanned operations. Design and develop advanced unmanned aircraft system (UAS) components to support goal of improved UAS performance. When applicable, technologies in this area are leveraged to support mitigation of degraded visual environments (DVE).	6.653	6.427	18.870

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47A / *AERON & ACFT Wpns Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2018 Plans: Mature autonomous flight control algorithms to support optionally manned helicopter flight operations. Design and develop tube launched UAS components to support manned unmanned teaming (MUM-T) of UAS with both manned and unmanned ground vehicles, building towards a UASs on-demand capability. Investigate system software and hardware architectures to make autonomous systems more resilient and adaptable to mission changes and system failures. Investigate multi modal cueing for increased situational awareness in all domains. Investigate management of aircrew workloads throughout mission execution, to include MUM-T. ***FY 2019 Plans:*** Will continue to investigate management of aircrew workloads throughout mission execution, to include advanced teaming. Will continue to develop algorithms for increased autonomy air platform autonomy and contingency management to support mission execution independent of a constant data link to a ground control station. Will investigate and evaluate human/machine interface technologies that enable reduced workloads, increased situational understating, and maximize human/machine performance in an aviation environment. Will evaluate technologies to support the following capabilities; resupply, reconnaissance, surveillance, electronic warfare, protection, medical evacuation and attack. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** This task funding has been increased to meet Army Future Vertical Lift Priority of Manned-Unmanned Teaming (MUM-T)			
Title: Maintainability & Sustainability Technologies ***Description:*** Enables highly reliable, low maintenance platforms that can survive un-sustained in the multi-domain battle space for extended periods. Explores enabling technologies comprising aircraft health state awareness, data driven sustainment approaches, and operationally durable designs. ***FY 2018 Plans:*** Investigate efforts to improve component prognostics capability for aviation systems. Investigate sensor and maintainability technologies that enable improved prognostics for an improved and integrated aircraft system health monitoring and management capability. Identify improved materials and processes that enhance system durability and reliability. Determine fleet and logistics management data interface and transfer gained knowledge. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** This task funding has been realigned to meet Army Future Vertical Lift Priority of Manned-Unmanned Teaming (MUM-T)	3.485	3.846	-
Accomplishments/Planned Programs Subtotals	54.082	55.630	53.884

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47A / *AERON & ACFT Wpns Tech*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602211A / *Aviation Technology*	Project (Number/Name) 47B / *Veh Prop & Struct Tech*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
47B: *Veh Prop & Struct Tech*	-	9.511	10.456	10.963	-	10.963	11.181	11.480	11.716	11.950	0.000	77.257

A. Mission Description and Budget Item Justification

This Project investigates engine, drive train, and airframe enabling technologies such as multifunctional materials, fluid mechanics and high temperature, high strength, low cost shaft materials. Additional areas of research include platform, aerodynamic, transmission, and control technologies for implementation in autonomous Unmanned Aerial Systems (UAS) and failure analysis and prediction models and techniques to support a "zero maintenance helicopter" concept.

Work in this Project complements and is fully coordinated with Program Element (PE) 0603003A (Aviation Advanced Technology) and leverages basic research performed in PE 0601104/Project H54 (Micro Autonomous Systems Technology Collaborative Technology Alliance) and PE 0601104/Project H09 (Robotics Collaborative Technology Alliance).

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Rotor and Structure Technology	2.524	2.335	2.706
Description: Devise improved tools and methodologies to more accurately design for improved component reliability and durability, resulting in platforms that are lighter in weight and less costly to acquire and maintain. Investigate rotors and structures to significantly improve rotorcraft range and speed.			
FY 2018 Plans: Develop an efficient computational, structural fatigue method to predict the growth of small cracks or even earlier material damage indicators relevant to Army aviation; conduct experiments to verify the fatigue method and improve the accuracy predictions for remaining structural fatigue life. Develop a computational model of a co-axial rotor system to understand the fundamental interactions between counter-rotating rotors and their effects on transient hub loads and rotor blade defections.			
FY 2019 Plans: Will explore techniques for coalescing data from structural sensors, novel damage models, and advanced multifunctional material systems for extreme light weighting. Improved aero elasticity modeling, along with uncertainty quantification and propagation across requirements, design variables, and technology maturity level will be investigated to enable air vehicle design. Technology enablers such as self-responsive materials/structures, three-dimensional topology optimization, and machine learning will be investigated to improve reliable and durable vehicle components.			
FY 2018 to FY 2019 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47B / *Veh Prop & Struct Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
This task funding has been increased to continue to explore techniques that will improve the reliability and durability of vehicle components for Future Vertical Lift (FVL).			
Title: Air Vehicle Propulsion and Power Technology (previously tittled: Engine and Drive Train Technology) ***Description:*** Applied research investigating engine and drivetrain technologies for Army manned and unmanned air vehicles. Research, investigates, and conducts experiments to develop, innovate, and validate advanced models and improved methods for propulsion system components and configurations to enable improvements in power density, efficiency, reliability and life cycle cost for increasing performance and capabilities of Army aviation systems. ***FY 2018 Plans:*** Investigate and conduct experiments on engine and drivetrain technologies to enable improved performance and reduced maintenance costs for Army vehicles including (a) performance of a centrifugal compressor vaneless diffuser; (b) a variable area fuel injection nozzle concept for improved control of fuel quantity and jet penetration; (c) innovative active and passive articulating turbine rotor and stator blade mechanism concepts; (d) research in ceramic matrix composite (CMC) turbine blades; (e) representation learning and model-assist diagnostic techniques for early damage detection in high-performance flight-critical powertrain gearing. ***FY 2019 Plans:*** Will conduct research that leads to enhancements in propulsion including material improvements for high temperature engine and high stress drivetrains, reliable air and fuel delivery components for robust energy conversion of multiple fuel inputs in small engine systems, and aerodynamic performance in high efficiency centrifugal compressors. Will investigate more accurate simulations capable of predicting nonlinear and shifting dynamics and damage in complex and variable speed helicopter drivetrains. Techniques for interactive trade space navigation across performance, cost and capabilities will be investigated, which ties user value measures to performance and effectiveness. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase to support additional efforts in small engines for Unmanned Air Systems	2.611	1.557	2.021
Title: Micro/Small Scale Unmanned Aerial Systems ***Description:*** Develop means to maximize the endurance of Soldier and robot portable aerial Intelligence, Surveillance, and Reconnaissance (ISR) assets through investigation of technologies such as adaptive materials for wings/airframes and an array of behaviors, spanning low-level reflexive controls through higher intelligence path and mission planning. ***FY 2018 Plans:*** Incorporate span adaptive wing structure into flight body, create appropriate flight behaviors, and assess resultant contribution to energy efficient yet agile flight. Experimentally collect data to validate and improve mission driven analytical Unmanned Aerial	3.401	4.064	3.736

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47B / *Veh Prop & Struct Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Vehicle (UAV) technology trade space tools. Develop physics-based analytical tools for assessing performance impacts of multi-material technologies for UAVs. ***FY 2019 Plans:*** Will develop the underlying aerodynamic models that will enable small Unmanned Aircraft System (UAS) to perform aggressive maneuver through complex environments, where the incorporation of higher fidelity methods into computationally efficient physics based modeling tools will enable the design of novel UAS concepts. Will carry out research that will enable advanced speed, endurance, payload capability, and on-demand design and fabrication of small-mission based UAS. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY19 funding decrease due to reduced resources needed to meet base plans			
Title: Aviation Component Failure Modeling ***Description:*** Develop failure analysis and prediction models and techniques to support a "zero maintenance helicopter" concept. Work is coordinated with Aviation component and system reliability efforts in PE 0602211A / Project 47A at the United States (U.S.) Army Aviation and Missile Research, Development and Engineering Center. ***FY 2018 Plans:*** Develop a more efficient probabilistic and risk assessment method that can predict aviation component failure as damage is initially detected and continues to progress. ***FY 2019 Plans:*** Will develop probabilistic models that will enable the prediction of useful life of advanced propulsion materials and components and failure prediction in aviation materials and structural components. Material and structural information can be used to inform damage-adaptive maneuvers in real-time to enable ?zero-maintenance helicopter? technologies.	0.975	1.000	1.000
Title: High Speed & Efficient Vertical Take-off and Landing ***Description:*** Perform Vertical Take-Off and Landing (VTOL) research investigations in propulsion, aeromechanics and platform technologies to explore, innovate and combine the most promising technologies to enable more efficient hover, high-speeds, and greater maneuverability at longer ranges for Army aviation. Reconfigurable and adaptive technologies include hover rotor systems that can achieve high speed, low drag; aerodynamic lift technologies capable of higher speed and efficient cruise; and convertible propulsion technologies to deliver more efficient hover and higher speed cruise power. ***FY 2018 Plans:*** Investigate and develop active and passive technologies for structural damping augmentation to overcome structural performance limitations by developing physics-based mathematical models to enable higher fidelity analysis for concept assessment and	-	1.500	1.500

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602211A / *Aviation Technology*	**Project (Number/Name)** 47B / *Veh Prop & Struct Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
capability projection. Investigate engine cycle and powertrain configuration concepts that enable efficient hover and high speed cruise. ***FY 2019 Plans:*** Will conduct research in the areas of propulsion and active/passive platform technology that will enable improved reliability, efficiency, and stability of VTOL vehicles. This will include research in emerging propulsion technology such as hybrid-electric concepts, and lightweight power distribution configuration, as well as in aeromechanics research to enable higher speeds and greater efficiency for reconfigurable rotor systems. Embedded sensing, actuation, and control methods will also be investigated.			
Accomplishments/Planned Programs Subtotals	9.511	10.456	10.963

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602211A / *Aviation Technology*	Project (Number/Name) *47C / ROTORCRAFT COMPONENT TECHNOLOGIES (CA)*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
47C: *ROTORCRAFT COMPONENT TECHNOLOGIES (CA)*	-	4.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.000

Note

Congressional Increase for FY17

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Rotorcraft Component Technologies.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Congressional Program Increase	4.000	-
FY 2017 Accomplishments: N/A		
Congressional Adds Subtotals	4.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602270A / *Electronic Warfare Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	34.528	27.144	25.571	-	25.571	26.008	26.451	26.868	27.415	0.000	193.985
475: *ELECTRONIC WARFARE COMPONENT TECHNOLOGIES (CA)*	-	10.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	10.000
906: *Tactical Electronic Warfare Applied Research*	-	24.528	27.144	20.203	-	20.203	21.063	21.506	21.824	22.270	0.000	158.538
CYB: *Applied Offensive Cyber*	-	0.000	0.000	5.368	-	5.368	4.945	4.945	5.044	5.145	0.000	25.447

Note

Project funding was realigned in FY19 from Project 906, Tactical Electronic Warfare Applied Research to Project CYB, Applied Offensive Cyber. Funding was realigned in accordance with Volume 2B, Chapter 18, of the DoD Financial Management Regulation (FMR), requiring all "cyberspace activities" funding move into pure budget Projects.

A. Mission Description and Budget Item Justification

This Program Element (PE) designs and validates electronic warfare (EW) components, both hardware and software, that deny, disrupt, or degrade the enemy's use of the electromagnetic spectrum for offensive or defensive operations. This is accomplished through the investigation of electronic support measures (ESM); countermeasures against communications systems and networks; the design and fabrication of sensors used to identify and locate threat forces in an asymmetric environment; and threat warning and electronic countermeasures (ECM) against munitions sensors, missile guidance systems, targeting systems, and explosive hazards. Project 906 supports protection of high-value ground platforms, aircraft and the Soldier from threat surveillance and tracking systems, imaging systems, and advanced radio frequency (RF)/electro-optical (EO)/infrared (IR) guided missiles, artillery, and smart munitions. Information fusion research addresses sensor correlation and fusion, relationship discovery, and management services through use of automated processing, as well as software that applies higher level reasoning techniques to support automated combat assessment. Project 906 also supports research and application of key EW sensors, direction finders and jammers to intercept, locate, and disrupt current and emerging communications and non-communications threat emitters to provide vital quality combat information directly to users in a timely and actionable manner. It focuses on detection of threat sensors and emitters associated with weapon systems, targeting systems and command, control, communications, computers, and intelligence systems and networks. Project CYB designs, creates, evaluates, and applies emerging cyber techniques and cyber situational awareness technologies to enhance Army capabilities and to mitigate risks and investigates cyber collection and mapping technologies to offer real time cyber situational awareness to enable interpretation of current threats and predict future enemy activities. .

Work in this PE complements PE 0602120A (Sensors and Electronic Survivability), PE 0602782A (Command, Control, Communications Technology), PE 0603270A (Electronic Warfare Technology), and PE 0603772A (Advanced Tactical Computer Science and Sensor Technology); and is coordinated with PE 0603710A (Night Vision Advanced Technology) and PE 0603794A (Command, Control and Communications Advanced Technology).

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army	Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602270A *I Electronic Warfare Technology*

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 Priorities.

Work is performed by the Army Research, Development and Engineering Command, Aberdeen Proving Ground, MD.

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	25.466	27.144	26.575	-	26.575
Current President's Budget	34.528	27.144	25.571	-	25.571
Total Adjustments	9.062	0.000	-1.004	-	-1.004
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	10.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.926	-			
• Adjustments to Budget Years	-	-	-1.004	-	-1.004
• FFRDC	-0.012	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: 475: *ELECTRONIC WARFARE COMPONENT TECHNOLOGIES (CA)*		
Congressional Add: *Congressional Program Increase*	10.000	-
Congressional Add Subtotals for Project: 475	10.000	-
Congressional Add Totals for all Projects	10.000	-

Change Summary Explanation

FY17 Congressional increase in 475 Electronic Warfare Component Technologies

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602270A / *Electronic Warfare Technology*	Project (Number/Name) 475 / *ELECTRONIC WARFARE COMPONENT TECHNOLOGIES (CA)*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
475: *ELECTRONIC WARFARE COMPONENT TECHNOLOGIES (CA)*	-	10.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	10.000

Note

Congressional Increase

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Electronic Warfare technology applied research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Congressional Program Increase	10.000	-
FY 2017 Accomplishments: N/A		
Congressional Adds Subtotals	10.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602270A / *Electronic Warfare Technology*	Project (Number/Name) 906 / *Tactical Electronic Warfare Applied Research*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
906: *Tactical Electronic Warfare Applied Research*	-	24.528	27.144	20.203	-	20.203	21.063	21.506	21.824	22.270	0.000	158.538

Note

Project funding was realigned in FY19 from Project 906, Tactical Electronic Warfare Applied Research to Project CYB, Applied Offensive Cyber. Funding was realigned in accordance with Volume 2B, Chapter 18, of the DoD Financial Management Regulation (FMR), requiring all "cyberspace activities" funding move into pure budget Projects.

A. Mission Description and Budget Item Justification

This Project designs, fabricates, evaluates, and applies key electronic warfare (EW)/information operations technologies to enhance platform survivability (to include ground combat vehicles, aircraft, and the dismounted Soldier) and to intercept, track and locate current and emerging threat munitions, communications and non-communications threat emitters. This project applies recent advances in radio frequency (RF), infrared (IR), and electro-optical (EO) sensors and jamming sources to detect, locate, deceive, and jam threats (to include radar directed target acquisition systems, target-tracking sensors, surface-to-air missiles (SAMs), air-to-air missiles (AAMs), top attack weapons, and electronically fuzed munitions). This project also pursues the ability to neutralize improvised explosive devices. This project designs information systems to provide vital, quality combat information directly to users in a timely, actionable manner in accordance with concepts for future force intelligence operations. This Project investigates RF collection and mapping technologies to offer real time emitter detection, location, and identification. In addition, this project enables a remote capability to disrupt, deny, or destroy threat communication signals and enables fusion (automated assimilation and synthesis) of battlefield intelligence data to enable interpretation of current threats and future enemy activities. This allows commanders to develop operational courses of action in time to act decisively and in a pre-emptive manner.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Multi-Intelligence Data Fusion and Targeting	2.560	2.780	-
Description: This effort investigates, designs and codes advanced automated exploitation and fusion analysis tools, applications, and software services for the creation of improved intelligence products, common information management and information dissemination systems to facilitate collaboration between intelligence and mission command functions. This will provide relevant and timely information in support of command decisions, such as high value identification and targeting in an asymmetric environment. Work being accomplished under Program Element (PE) 0603772A/Project 243 complements this effort. In FY 2019, efforts are realigned to ?Data Analytics for Situational Awareness? to support the Army science and technology (S&T) priorities as identified at the December 2016 S&T Army Requirements Oversight Council by the Chief of Staff of the Army.			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602270A / *Electronic Warfare Technology*	**Project (Number/Name)** 906 / *Tactical Electronic Warfare Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2018 Plans: Mature predictive analyst tools to determine patterns, anomalies and behavior to correlate and exploit big data sources; develop techniques and software tools to correlate dark web with clear web organizational personas; develop cyber threat indicators and ratios for identification of group patterns, tactics, techniques and procedures; and apply stylometry and authorship principles to cyber content to identify and group adversarial cyber themes. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** In FY 2019, efforts are realigned to ?Data Analytics for Situational Awareness? to meet Army priority for Network/C3I.			
Title: Data Analytics for Situational Awareness ***Description:*** This effort researches and designs spectrum sensing, electronic sensing and intelligence collection technologies and analytics to enhance overall situational understanding within a contested battlespace. Efforts focus on developing the analytics necessary to taking advantage of the expanding number of data sources available by leveraging existing tactical receivers and other tactical data feeds. Work being accomplished under Program Element (PE) 0603772A/Project 243 complements this effort. In FY 2019, efforts are realigned to support the Army science and technology (S&T) priorities as identified at the December 2016 S&T Army Requirements Oversight Council by the Chief of Staff of the Army. ***FY 2019 Plans:*** Will identify relevant tactical receiver data and emerging Internet of Things (IoT) data sources, to include publicly available information, enriching the existing cyber terrain and electromagnetic operations environment; will investigate potential correlation points with non-traditional datasets to identify cyber events; and will explore new data analytics, fusion algorithms and semi-automated analytical methods to process and exploit the extended datasets to support cyber situational understanding. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** New effort to meet Army priority for Network/C3I.	-	-	2.946
Title: Offensive Information Operations Technologies ***Description:*** This effort designs, codes and evaluates techniques for radio frequency (RF) network mapping, surgical disruption and unobtrusive operations in the presence of host nation networks. Electronic warfare capabilities include detection, location, classification, mapping and disruption of RF networks and providing data to a user. Work being accomplished under PE 0602270A/Project CYB and PE 0603270A/Projects CY3 and K15 complements this effort. In FY 2019 cyber work in this effort was moved to Project CYB per an Office of the Secretary of Defense directive to identify cyber investments in cyber unique Projects. In FY 2019, efforts are realigned to support the Army science and technology (S&T) priorities as identified at the December 2016 S&T Army Requirements Oversight Council by the Chief of Staff of the Army.	7.857	7.984	2.470

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602270A / *Electronic Warfare Technology*	**Project (Number/Name)** 906 / *Tactical Electronic Warfare Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2018 Plans: Validate advanced, software techniques to perform various cyber/EW functions against identified SOIs and devices of interest (DOIs); conclude requirements investigation and analysis of software architecture to allow the tactical commander to direct and control cyber functions from EW and SIGINT platforms across/within security domains and battlespace domain resources; and incorporate the results of cyber laboratory experiments into the next generation architecture requirements and analysis of analytic tools that can inform the commander's situational understanding; and design and code the data models necessary for the delivery of CEMA data products to the intelligence enterprise. ***FY 2019 Plans:*** Will investigate emerging networks to identify shortfalls in capability to detect, identify and map network nodes; identify future analytic, sensor, and data research needs; and investigate techniques for surgical disruption and unobtrusive operation within native network infrastructures. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decrease funding in Offensive Cyber Technologies to meet Army priority for Network/C3I, and Offensive Cyber Technologies STO task ends in FY18.			
Title: Multispectral Threat Warning and Countermeasures, formerly Multispectral Threat Warning ***Description:*** This effort investigates and evaluates software and warning sensor/countermeasure components to increase probability to detect and defeat current and evolving small arms and man-portable air defense system (MANPADS) type threats for aviation platforms using modeling and simulation (M&S) and hardware in the loop (HWIL) simulations. Work being accomplished under PE 0603270A/Project K16 complements this effort. ***FY 2018 Plans:*** Investigate threat agnostic warning algorithms to increase probability of detection of threats and provide identification and position information to the countermeasure system for an increased probability of defeat; based upon feasibility study results, investigate novel techniques using lasers of higher energy than currently used to increase the probability of defeat of threats not previously encountered; use M&S to develop new threat scenarios and mature HWIL simulations that sense the electro-magnetic environment to assess existing countermeasure capabilities against previously unknown threats; investigate higher fidelity countermeasures and incorporate them into the simulation environment; investigate threat agnostic countermeasure techniques against previously unknown threats and investigate the effects of combined EO/IR/RF technologies to defeat both multiple and multi-spectral threats. ***FY 2019 Plans:***	5.051	6.605	6.935

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602270A / *Electronic Warfare Technology*	**Project (Number/Name)** 906 / *Tactical Electronic Warfare Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Will investigate technologies to indiscriminately detect and defeat broad classes of threats; will conduct analysis of next-generation detect technologies with focus on machine learning algorithms to enable detection of unrecognized threat features; will conduct analysis of advanced defeat technologies focusing on new lasers and laser materials and build a breadboard laser to indiscriminately degrade electro-optical (EO) threat sensor performance; will investigate radio frequency (RF) digital hardware and software techniques that are adaptive to agile RF threats; will use M&S to iteratively train machine learning algorithms to perform threat classification and optimize laser countermeasure and RF technique development; and assess performance of technologies (e.g., machine learning, lasers, etc.) and techniques independently and incorporate them into a digital M&S platform. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase to assess performance of technologies and techniques independently and incorporate them into a digital modeling and simulation platform.			
Title: Multi-Function Intelligence, Surveillance and Reconnaissance Technologies	8.060	8.771	7.352
Description: This effort investigates and codes software algorithms and techniques to intelligently integrate tactical Intelligence, Surveillance, and Reconnaissance (ISR) sensors, improve their individual performance and increase the effectiveness of battlespace awareness/intelligence data in an area of operations. Efforts focus on networking of sensors and open, scalable common radio frequency (RF) architectures for terrestrial and aerial sensors. Work being accomplished under PE 0603270A / Project K15 and PE 0603772A / Project 243, PE 0602709A/project H95 and PE 0603701A / Project K70 complement this effort. ***FY 2018 Plans:*** Conduct experiments on reference design for multi-channel receiver architecture to assess baseline performance of commercial and Government off the shelf (COTS/GOTS) receivers to determine optimal size, weight, and power and cost for a variety of electronic warfare (EW) and Signals Intelligence (SIGINT) missions, including direction finding and beamforming functions; continue to mature and validate Open RF Architecture interface specifications to support advanced interference mitigation between RF functionalities (e.g., communications, SIGINT and blue force jamming); mature interface specifications of intermediate processing functions to enable multi mission EW and SIGINT operations; standardize application interfaces across cyber, EW and SIGINT mission spaces to enable coordinated command and control (C2) of these capabilities to better address emerging threat signal classes; and begin investigation of Next Generation Radar architecture for compatibility with EW and SIGINT missions and architectures. ***FY 2019 Plans:*** Will research enhanced next generation techniques for distributed sensing and single sensor geolocation to enable detection, and geolocation of advanced threats and inform requirements for future hardware designs; will investigate state of the art electronic situational awareness technique susceptibility to adversarial use of next generation RF deception and jamming; will investigate cyber hardening of sensor component technology for front-end sensors; investigate a best-of-breed low-cost HF software defined			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602270A / *Electronic Warfare Technology*	**Project (Number/Name)** 906 / *Tactical Electronic Warfare Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
radio for use in an open multifunction ISR platform to be utilized in a hostile cyber environment; will explore trade space of shared multi-function next generation hardware for Radar, SIGINT and EW; perform tradeoff studies to understand the feasibility and impact of executing multi-function capabilities from a common RF array with consideration for advancing threat electronic protection capability; and will perform laboratory sensing data collections and analysis to address the applicability of a multi-function sensor. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decrease due to conclusion of work to mature interface specifications of intermediate processing functions to enable multi mission EW and SIGINT operations.			
Title: Electronic Warfare Architectures and Countermeasures ***Description:*** This effort investigates and evaluates the technical specifications of a family of threats to develop non-kinetic countermeasures. Work being accomplished under PE 0603270A/Project K16 complements this effort.	1.000	-	-
Title: Multi Function Electronic Warfare (MFEW) Technique Development ***Description:*** This effort investigates and develops electronic warfare (EW) techniques critical to countering communications, such as networked command and control nodes or improvised explosive device threats, and radars, such as ground surveillance and counter-fire radars. The techniques developed are system agnostic and applicable to a wide variety of EW and electronic countermeasure applications, and they can be used to improve the performance and expand the functionality of both current and future EW system capabilities. Work being accomplished under PE 0603270A/Project K16 complements this effort. ***FY 2018 Plans:*** Investigate and perform vulnerability analysis on emerging commercial communications capabilities and investigate/develop EW techniques and methods (such as active, reactive, surgical and protocol based software) to defeat specific commercial communications systems while maximizing waveform jamming effectiveness, minimizing transmission time and reducing jamming power. ***FY 2019 Plans:*** Will investigate and perform vulnerability analysis on emerging threats (including, but not limited to, tactical communications, ground surveillance radar, and counter-fire radar systems) and mature EW techniques and methods (such as active, reactive, surgical, and protocol based software) with the goals of maximizing EW waveform jamming effectiveness, minimizing transmission time, and reducing jamming power to defeat Army relevant threats. ***FY 2018 to FY 2019 Increase/Decrease Statement:***	-	1.004	0.500

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602270A / *Electronic Warfare Technology*	**Project (Number/Name)** 906 / *Tactical Electronic Warfare Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Decrease effort in MFEW to meet Army priority for Network/C3I.			
Accomplishments/Planned Programs Subtotals	24.528	27.144	20.203

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602270A / *Electronic Warfare Technology*	Project (Number/Name) CYB / *Applied Offensive Cyber*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
CYB: *Applied Offensive Cyber*	-	0.000	0.000	5.368	-	5.368	4.945	4.945	5.044	5.145	0.000	25.447

Note

Project funding was realigned in FY19 from Project 906, Tactical Electronic Warfare Applied Research to Project CYB, Applied Offensive Cyber. Funding was realigned in accordance with Volume 2B, Chapter 18, of the DoD Financial Management Regulation (FMR), requiring all "cyberspace activities" funding move into pure budget Projects.

A. Mission Description and Budget Item Justification

This Project designs, creates, evaluates, and applies emerging cyber techniques and cyber situational awareness technologies to enhance Army capabilities. This Project leverages behavioral Modeling and Simulation to mitigate risks and investigates cyber collection and mapping technologies to offer real time cyber situational awareness to enable interpretation of current threats and predict future enemy activities. This allows commanders to develop operational courses of action in time to act decisively and in a pre-emptive manner.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Offensive Information Operations Technologies	-	-	5.368
Description: This effort designs, codes and evaluates cyber architectures, software, tools and techniques that identify and capture data traversing targeted networks for the purpose of Cyber Electro Magnetic Activity (CEMA) or otherwise countering adversary communications. Cyber capabilities include detection, identification, exploitation, direction finding (DF), geolocation, and denial of service. Work being accomplished under PE 0603270A/Projects CY3 and K15 and PE 0602270A/Project 906 complements this effort. Project funding was realigned in FY19 from Project 906, Tactical Electronic Warfare Applied Research to Project CYB, Applied Offensive Cyber. Funding was realigned in accordance with Volume 2B, Chapter 18, of the DoD Financial Management Regulation (FMR), requiring all "cyberspace activities" funding move into pure budget Projects..			
FY 2019 Plans: Will investigate utilizing Machine Learning for threat assessment, decision aid, and mission choreography; will determine algorithm design needs for recognition and Battle Damage Assessment for the purposes of survey, network topology understanding, and effect assessment; will refine CEMA interface definitions to include a mechanism for service/capability discovery to address solidifying mission management across Unified Land Operations platforms.			
FY 2018 to FY 2019 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602270A / *Electronic Warfare Technology*	**Project (Number/Name)** CYB / *Applied Offensive Cyber*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Project funding was realigned in FY19 from Project 906, Tactical Electronic Warfare Applied Research to Project CYB, Applied Offensive Cyber. Funding was realigned in accordance with Volume 2B, Chapter 18, of the DoD Financial Management Regulation (FMR), requiring all "cyberspace activities" funding move into pure budget Projects..			
Accomplishments/Planned Programs Subtotals	-	-	5.368

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602303A / *Missile Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	66.173	43.742	50.183	-	50.183	50.468	55.097	51.240	45.228	0.000	362.131
214: *Missile Technology*	-	42.673	43.742	50.183	-	50.183	50.468	55.097	51.240	45.228	0.000	338.631
G05: *MISSILE TECHNOLOGY INITIATIVES (CA)*	-	23.500	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	23.500

A. Mission Description and Budget Item Justification

This Program Element (PE) designs, fabricates and evaluates advanced component technologies for tactical missiles, rockets, guided munitions, and their launch systems in order to increase lethality, precision, and effectiveness under adverse battlefield conditions while reducing system cost, size and weight. Major goals in Project 214 include enhancing the survivability of the munition, launch and fire control systems and increasing kill probabilities against diverse targets.

The work in this PE is complimentary to PE 0603313A (Missile and Rocket Advanced Technology) and fully coordinated with PE 0602307A (Advanced Weapons Technology), PE 0602618A (Ballistics Technology, Robotics Technology), PE 0602624A (Weapons and Munitions Technology), PE 0603004A (Weapons and Munitions Advanced Technology), PE 0602782A (Command, Control, Communications Technology), and PE 0708045A (End Item Industrial Preparedness Activities).

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

The work in this PE is performed by the Army Research, Development and Engineering Command (RDECOM).

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	44.313	43.742	46.919	-	46.919
Current President's Budget	66.173	43.742	50.183	-	50.183
Total Adjustments	21.860	0.000	3.264	-	3.264
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	23.500	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.619	-			
• Adjustments to Budget Years	-	-	3.264	-	3.264
• FFRDC	-0.021	-	-	-	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army	Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: G05: *MISSILE TECHNOLOGY INITIATIVES (CA)*		
Congressional Add: *Congressional Program Increase*	15.000	-
Congressional Add: *Weapon Effectiveness in urban engagement*	8.500	-
Congressional Add Subtotals for Project: G05	23.500	-
Congressional Add Totals for all Projects	23.500	-

Change Summary Explanation

FY17 Congressional increase in G05 Missile Technology Initiatives. FY19 funding increased in this PE to address higher priority Army Modernization efforts in the area of Air and Missile Defense.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602303A / *Missile Technology*	Project (Number/Name) 214 / *Missile Technology*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
214: *Missile Technology*	-	42.673	43.742	50.183	-	50.183	50.468	55.097	51.240	45.228	0.000	338.631

A. Mission Description and Budget Item Justification

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

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

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Missile Seeker Technology	4.659	4.740	4.761
Description: This effort focuses on the design, fabrication and evaluation of missile seekers, sensors, and software. The goal is to increase affordability and performance of missile seekers through improvement of algorithms, imaging, and thermal management.			
FY 2018 Plans: Develop feature extraction/classification and tracker algorithms for resolved and unresolved unmanned aerial system to supplement existing surveillance assets; continue to develop infrared passive precision acquisition and tracking algorithms for true fire-and-forget engagements in GPS-denied environments with seeker hardware and interface formed for use on small guided munitions with modular open systems architectures; investigate technologies that support a low cost, strap down seeker system for counter unmanned aerial systems and will evaluate potential missile guidance errors; conduct design analysis for field of view, stabilization, resolution for a man-portable, Air Defense missile and investigate the performance of tactical optics over temperature with the use of additive manufacturing; develop a compact, low cost laser ranging sensor for range finding and target detection of personnel in defilade and develop a height of burst sensor for lethality against personnel.			
FY 2019 Plans: Will enhance infrared passive precision acquisition and tracking algorithms for true fire-and-forget engagements in global positioning system (GPS)-denied environments; will design, fabricate and evaluate novel mechanical designs utilizing additive			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*	**Project (Number/Name)** 214 / *Missile Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
manufacturing and new materials for optical sensor applications to enable lower cost infrared seeker optics; perform design analysis to determine man-portable, Air Defense missile seeker requirements and will develop robust seeker modeling and simulation tools to verify design parameter; will design, fabricate and evaluate technologies that support a low cost, strap down, active, electro-optic seeker system for counter unmanned aerial systems (UAS) and counter ground target missiles; design concepts for a multi-band active optical tracker that laser-designates small UAS to increase probability of defeat for seeker based kinetic weapons. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase due to inflation.			
Title: Missile Guidance, Navigation and Controls Technologies	7.630	7.773	8.424
Description: This effort designs, fabricates and evaluates guidance, navigation, and control systems and software, as well as information and signal processing systems for rocket and missile applications. Goals of this effort include more affordable missile guidance; miniaturization of guidance electronics; maintaining performance in global positioning system (GPS) denied environments; improved image processing; improved missile power systems; improved communication with ground and other systems; technologies to track and respond to threat and offensive munition swarms. ***FY 2018 Plans:*** Refine and develop a multi-sensor survey system by integrating inertial navigation sensors, chip-scale atomic clock (CSAC), optics and Global Positioning System (GPS) to provide highly accurate Position, Navigation and Timing (PNT) data in GPS degraded or denied environments; refine the design of small, precision inertial sensors/accelerometers for fast, accurate north-finding required to support target location systems/missile initialization; continue design and fabrication of test articles for increased current capacity batteries for long range, small guided missiles; combine Radio Frequency (RF) and electronics in 3-dimensional (3D) printed objects, generate models and databases, and assess applications to reduce size, weight, and cost of missile systems; design microelectromechanical systems (MEMS) gyroscope and optical frequency shifting device for next generation inertial sensors; develop laser source filters for semi-active Laser seeker optics and develop advanced machine intelligence and image processing techniques for enhanced target acquisition and engagement; investigate magneto-electric composites, advanced system-on-a-chip (SoC) integrated circuit electronics parts, and design processes that reduce the amount of thermal buildup. ***FY 2019 Plans:*** Will perform investigation and performance analysis of a multi-sensor survey emplacement system for GPS degraded or denied environments; will fabricate and develop microelectromechanical systems (MEMS) concentric proof mass gyroscope for next generation inertial sensor; will investigate radio frequency (RF) ? based navigation via RF range-finding datalinks as a GPS-independent position aid; will investigate a non-line-of-sight datalink for airborne loitering missiles with air/ground launch capability; will complete evaluation of experimental articles for increased current capacity batteries for long range, small guided			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*	**Project (Number/Name)** 214 / *Missile Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
missiles; develop magnetoelectric composites, advanced system-on-chip (SoC) integrated circuit electronics parts, and will design processes that reduce the amount of thermal buildup enabling significant improvements in overall material performance and size/weight reduction; will develop a 4-D printing technology where the printed device properties vary continuously throughout the structure creating a material with varied resistive, graded dielectric, electrical, and thermal management to support RF components; will further develop and evaluate laser source filters for semi-active Laser seeker optics, advanced machine intelligence, and image processing techniques for enhanced target acquisition and engagement. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase due to continue efforts to investigate guidance and navigation technologies for GPS degraded/denied environments.			
Title: Missile Fire Control Systems, Sustainment, Simulations, and Launchers	7.355	7.409	7.017
Description: This effort designs and evaluates fire control and tracking sensor technologies for area protection and air defense, technologies to increase the longevity of developed missiles and reliability, advanced simulations to increase performance and reduce size, weight, and cost of missile systems, and launcher technology to deliver effects from air and ground platforms. Fire control radar effort is in coordination with PE 0602270A, Project 906 and PE 0603772A, Project 243. ***FY 2018 Plans:*** Further development of the Digital Array Radar Testbed (DART) to be used in the development of methods to counter evolving threats and maintain overmatch capability; further fabrication and evaluation of transmit/receive element array for increased firm track ranges and higher update rates; refine the Interface Control Document (ICD) between the digital radar testbed antenna array front-end and the Future Fires Radar open systems architecture back-end processing software to ensure compatibility and utilization for air defense capabilities; investigate a radar employing a Low Probability of Intercept chaotic waveform to detect and track small Unmanned Aircraft System (UAS) systems and document results to quantify system performance and investigate the transition of the technology to other Army Air Defense radars; will refine target identification algorithms for targets of interest with multiple sensor; further develop the design of modeling and simulation tools to enable increased weather fidelity with simultaneous results across all United States (US) and world climates; further develop UAS modeling validation processes with establishment of radio frequency (RF) predictive methodologies; investigate designs for missile airframe stability and control that includes advanced materials and miniature actuator technology; establish behind armor debris prediction capabilities for multiple shaped charge materials and designs; investigate missile battery aging behavior and mechanisms responsible for degraded reliability; investigate the viability of an affordable common, man-portable fire control system to launch both ground and Air Defense missile. ***FY 2019 Plans:*** Will further develop DART technologies; will design and develop the full array beginning with RF characterization, digital beam forming evaluations, and algorithm and scenario development; maintain compatibility with Future Fires Radar open systems architecture back-end processing; will refine and increase capabilities for target identification and discrimination algorithms utilizing threat flight dynamics and multiple sensors; will develop amplitude modulated pulse waveforms for next generation radars			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*	**Project (Number/Name)** 214 / *Missile Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
and seekers in order to improve target resolution and discrimination for challenging air defense scenarios; will develop a generic algorithm and design antennas that allow the use of non-linear conformal antenna structures across any arbitrary array and operating frequency to reduce effective sensor size, weight, and power (SWAP); will investigate and design an open/modular architecture for future missile health monitoring units (HMUs) that address shortfalls/limitations in existing fielded capability and accommodate lower cost/quicker expansion of missile HMU capability; will develop and demonstrate subscale novel conductive materials capable of supplementing battery life, and also have the ability to be electrically ignited to increase lethality; will develop modeling & simulation capabilities of hypersonic vehicles in low density flows at high altitude and develop a supersonic inlet code tailor made for air breathing missile propulsion enabling rapid design decisions. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decrease due to moving aerodynamic simulation activities into areas to further excel Propulsion, Structures, Lethality and Aero technologies.			
Title: Missile Propulsion, Structures, Lethality, and Aerodynamic Technology ***Description:*** This effort designs, fabricates, evaluates and tests missile enabling technologies including: advanced missile propulsion with reduced launch signatures; increased lethality and reduced weight and size using advanced materials and additive manufacturing. Missile Propulsion, Structures and Lethality efforts are in coordination with PE 0602618A, Project H80 and PE 0602624A, Project H28. ***FY 2018 Plans:*** Conduct static test firings in representative propellant grain geometries for both minimum smoke and high performance propellants; investigate attributes of technology to mitigate temperature sensitivity of reduced shock-sensitivity minimum smoke propellants; investigate low-cost integral rocket ramjet solutions, including combustion testing of advanced fuels, for Army missions to allow extended range within a smaller size than achievable using all-solid propulsion approaches; validate laser welding process and electrically conductive coating technology to reduce weight and cost of composite structures; design and test novel warhead technologies for providing overwhelming catastrophic effects against current and emerging threat vehicles to include Main Battle Tanks (MBT); refine concept characterization and integration experiments of brassboard designs of advanced shaped charge, explosively formed penetrators, and fragmentation technologies to enhance warfighter lethality and provide overmatch; investigate approaches to reduce multi-spectral launch signature for minimum smoke propulsion systems; investigate the utility of a low-cost pulsed solid rocket motor approach to provide enhanced mission flexibility for aviation-launched small guided missiles; investigate modeling tools, additive manufacturing processes, and materials to optimize performance and reducing weight and cost of missile structures; investigate lethality performance low-cost reactive penetrators against dispersed targets. ***FY 2019 Plans:***	5.658	5.749	7.315

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*	**Project (Number/Name)** 214 / *Missile Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Will investigate and characterize enabling energetic technologies for applications to missile propellants; will perform final characterization and evaluation of next generation minimum smoke propellants that improve missile performance via reduced burning rate sensitivity; will further develop low-cost integral rocket ramjet technology for extended range deep strike capability; will demonstrate techniques for reducing rocket motor light emissions sufficient to defeat adversary?s launch detection methods for increased survivability; will develop advanced hardware and subsystem technology to enable mission flexibility via dual pulse motor for future small guided missiles from rotary wing and UAS platforms; will design and develop high performance variable thrust and impulse technologies that can efficiently operate over extended duty cycles, altitudes, and tactical temperatures providing enhanced capabilities against highly maneuverable targets; will design and analyze of high temperature materials supporting high flight speed missiles and dynamic end game scenarios; will further develop modeling tools, additive manufacturing processes, and materials to optimize performance and reducing weight and cost of missile structures; will develop and perform proof of principle testing of novel warhead technologies for providing overwhelming catastrophic effects against current and emerging threat vehicles to include Main Battle Tanks (MBT); will design and develop warhead subsystem analysis of advanced shaped charge, explosively formed penetrators, and fragmentation technologies to enhance warfighter lethality and provide overmatch; will develop lethality simulations utilized for trade space and predicting the probability of kill for multiple-purpose warhead configurations against multiple target classes. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase due to moving aerodynamic simulation activities into areas to further excel Structures, Lethality and Aero technologies. Also, moved Propulsion efforts from Multi-role Missile Technology into this effort.			
Title: Multi-Role Missile Technology	6.099	4.070	1.770
Description: This effort evaluates critical technology and designs component for future affordable rockets and missiles to provide overwhelming defeat of conventional and asymmetrical threats in all environments. Successful technologies are matured and demonstrated in PE 0603313A, Project 263/704. ***FY 2018 Plans:*** Continue detailed designs and component development of low-cost guidance, navigation and control systems; multi-purpose warhead/fuzing technologies; and low-cost range finding and sighting systems for small unit precision lethality against multiple targets at extended ranges; design and conduct laboratory evaluations of subsystems for expanding the applicability of the modular open systems architecture to the drop/glide variant missile. ***FY 2019 Plans:*** Will mature modular missile technology components and open system architecture into subsystems and verify subsystem performance for the drop/glide variant in bench-level and laboratory environments. ***FY 2018 to FY 2019 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*	**Project (Number/Name)** 214 / *Missile Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Decrease due to funding moved to begin new effort, Cooperative Engagement Lethality Technology.			
Title: Air Defense Missile Technologies (formerly Counter Unmanned Aerial Systems and Counter Cruise Missile) ***Description:*** This effort evaluates and provides technologies and performs necessary trade studies to provide the key components for maturation and demonstration of air defense missiles to counter threats such as Unmanned Aircraft System (UAS) and cruise missile systems. This work supports efforts in PE 0603313A, Projects 263 & 704. ***FY 2018 Plans:*** Further the design of critical air defense interceptor technologies and components; perform the mission computer, and power system laboratory bench testing and demonstration in preparation for integration into guidance electronics units for the Ballistic and Control Test Vehicle evaluations; continue design of the control actuation system and demonstrate it in laboratory dynamic flight test simulation apparatus; design and develop software algorithms to provide common targeting data across multiple tactical echelons, enabling a common operating picture for maneuver and fire support weapon targeting. ***FY 2019 Plans:*** Will further the design of critical air defense interceptor technologies and components; will mature guidance electronics units for the Ballistic and Control Test Vehicle evaluations and will conduct Ballistic Test Vehicle Flight Testing; mature the control actuation system and demonstrate it in laboratory dynamic flight test simulation apparatus; will continue to develop software algorithms to fuse data from radar, electro-optical/Infrared, and acoustic sensors enabling a common operating picture of threat unmanned aerial systems. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase due to funding for accelerating capability for a maneuver-short range air defense interceptor.	5.176	5.368	8.501
Title: Affordable Precision Missile Enabling Technology ***Description:*** This effort focuses on the studies, design, establishment, fabrication, and evaluation of components and subsystems critical to produce affordable discriminate extended range precision missiles. Critical component technologies include: advanced propulsion, seekers/sensors, fire control, datalink, guidance, navigation and controls, and airframes. These technologies transition to PE 0603313A, Project 263 for maturation. ***FY 2018 Plans:*** Refine component/subsystem trade studies and begin to design, fabricate and test component technologies to provide the capability to engage maritime targets with lethal effects. Critical component technologies include: sensors, data-links, guidance, navigation, controls, aerodynamics, thermal protection systems and fuze integrated payloads. ***FY 2019 Plans:***	1.970	3.787	2.276

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*	**Project (Number/Name)** 214 / *Missile Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Will perform trade studies, develop concepts, generate designs, and explore technologies for affordable discrimination of extended range precision missiles for indirect fires capabilities. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decrease due to funding for capability to engage maritime targets with lethal effects funding being transferred into Long Range Fire Enabling Technology.			
Title: Long Range Fires Enabling Technology ***Description:*** This effort focuses on performing the necessary trade studies, and designing, establishing, fabricating and evaluating critical component technologies needed to support a long range fires capability. These technologies transition to PE 0603313A Project 263 for maturation. ***FY 2018 Plans:*** Investigate emerging navigation technologies and techniques; design navigation system integration architectures and algorithms capable of combining emerging navigation technologies into an alternate precision navigation solution; design propulsion systems to increase the range of the system; design light weight airframe structures to increase range of the system. ***FY 2019 Plans:*** Will continue to develop and evaluate emerging navigation technologies and techniques; will design navigation system integration architectures and algorithms capable of integration emerging navigation technologies into an enhanced precision navigation solution; will design propulsion systems, including alternate propulsion cycles, to increase the range of the system; will design lightweight airframe structures to increase range of the system; will develop technologies that contribute to missile survivability in a contested environment. Will develop and evaluate a multi-mode seeker to enable precision guidance in global positioning system (GPS) denied or degraded environments; radio frequency sensor to guide to radiating targets, infrared sensor with advanced image processing to enable target classification and aim point selection for both land and maritime targets; miniaturization of sensor and guidance components; investigate data link technologies to provide in-flight target updates. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase due to funding for capability to engage maritime targets with lethal effects being moved into this effort.	4.126	4.846	6.711
Title: Cooperative Engagement Lethality Technology ***Description:*** This effort investigates critical component technology and designs for future missiles that provide expeditionary, scalable, precision strike and loiter capability to rapidly defeat hard targets and swarming or disbursed threats at the Tactical Edge. Provides the missile technology path to supervised autonomous target detection and cooperative engagement/manned-unmanned teaming for offensive, multiple simultaneous engagement capabilities. These efforts transition to PE 0603313A, Project 263 for maturation.	-	-	3.408

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602303A / *Missile Technology*	**Project (Number/Name)** 214 / *Missile Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2019 Plans: Will develop optimized missile design with multi-effects lethal mechanism, man-in-the-loop and loiter capability for situational awareness, targeting, and lethal effects against hard and soft targets. WIll develop application-based fire control unit software hosted on a commercial end user device, extended range datalink enablers, and GPS/comms denied navigation/targeting technologies. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** New focus area in FY19.			
Accomplishments/Planned Programs Subtotals	42.673	43.742	50.183

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602303A / *Missile Technology*	Project (Number/Name) G05 / *MISSILE TECHNOLOGY INITIATIVES (CA)*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
G05: *MISSILE TECHNOLOGY INITIATIVES (CA)*	-	23.500	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	23.500

Note

Congressional Program increase for FY17

A. Mission Description and Budget Item Justification

This is a Congressional Interest Item.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Congressional Program Increase ***FY 2017 Accomplishments:*** N/A	15.000	-
Congressional Add: Weapon Effectiveness in urban engagement ***FY 2017 Accomplishments:*** N/A	8.500	-
Congressional Adds Subtotals	23.500	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602307A / *Advanced Weapons Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	52.766	22.785	29.502	-	29.502	24.457	26.190	26.780	27.316	0.000	209.796
042: *High Energy Laser Technology*	-	27.766	22.785	29.502	-	29.502	24.457	26.190	26.780	27.316	0.000	184.796
NA5: *Advanced Weapons Components (CA)*	-	25.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	25.000

A. Mission Description and Budget Item Justification

This Program Element (PE) investigates enabling technologies for High Energy Laser (HEL) weapons. Project 042 develops component technologies such as efficient, high energy, solid state lasers; advanced beam control components; and lethality / effectiveness measurements that enable better models and simulations for future HEL weapon designs.

Work in this PE is related to, and fully complements, efforts in PE 0601101A (In-House Laboratory Independent Research), PE 0602120A (Sensors and Electronic Survivability) Project EM8, PE 0603004A (Weapons and Munitions Advanced Technology) Project L96 and Air Force PE 0602890F (HEL Research).

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

Work is performed by the United States Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT) in Huntsville, AL, and the High Energy Laser Systems Test Facility at White Sands Missile Range, NM.

B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	28.803	22.785	29.502	-	29.502
Current President's Budget	52.766	22.785	29.502	-	29.502
Total Adjustments	23.963	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	25.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.023	-			
• FFRDC	-0.014	-	-	-	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army	Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602307A *I Advanced Weapons Technology*

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: NA5: *Advanced Weapons Components (CA)*		
Congressional Add: *Congressional program increase*	25.000	-
Congressional Add Subtotals for Project: NA5	25.000	-
Congressional Add Totals for all Projects	25.000	-

Change Summary Explanation

Congressional increase in NA5 Advanced Weapons Components

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602307A / *Advanced Weapons Technology*	Project (Number/Name) 042 / *High Energy Laser Technology*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
042: *High Energy Laser Technology*	-	27.766	22.785	29.502	-	29.502	24.457	26.190	26.780	27.316	0.000	184.796

A. Mission Description and Budget Item Justification

This Project investigates and develops advanced technologies for High Energy Laser (HEL) weapon systems to enable more efficient laser systems with greater power output. This includes technologies to support development of alternate laser sources, precision optical pointing and tracking components, adaptive optics to overcome laser degradation due to atmospheric effects, and thermal management systems to remove excess heat. In addition, this effort validates laser lethality performance and conducts analyses against a variety of targets and investigates the impact of low-cost laser countermeasures. This project includes laboratory efforts for HEL applied research as well as concepts analysis for United States Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT) Technical Center competencies in directed energy, missile defense, and space technical areas. Solid State Laser (SSL) efforts continue to leverage other funds provided by the HEL Joint Technology Office (JTO), the Air Force, and the Navy to develop multiple technical approaches that reduce program risk and maintain competition.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Solid State Laser Effects	3.429	3.674	4.200
Description: This effort provides the underlying data required to support high energy laser weapon system effectiveness analyses. This activity includes the full spectrum of lethality testing from fundamental physics investigations to the engagement of flying targets in relevant scenarios. This activity is primarily executed at the Solid State Laser Testbed (SSLT) facility at White Sands Missile Range, New Mexico.			
FY 2018 Plans: Assess laser countermeasure effectiveness to include hardened materials, optical countermeasures, and tactics. Begin assessment of advanced threats to include: Anti-Tank Guided Missiles, Radar Systems, Rocket-Propelled Grenades (RPGs), and ground vehicles.			
FY 2019 Plans: Will complete vulnerability modules and lethality database inputs for UAS Groups 1, 2, and 3. Will continue development of lethality database input for rocket, artillery, and mortar (RAM) threats supporting High Energy Laser Tactical Vehicle Demonstrator (HEL TVD). Will begin investigating lethal/aimpoint on manned fixed- and rotary-wing aircraft.			
FY 2018 to FY 2019 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602307A / *Advanced Weapons Technology*	**Project (Number/Name)** 042 / *High Energy Laser Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Increase due to initiation of laser vulnerability data collection to support new Future Vertical Lift effort			
Title: Advanced Beam Control Component Development ***Description:*** This effort investigates technologies to enable lighter, more agile beam control systems that are robust enough to be used in Army platforms. This work is done in collaboration with the High Energy Laser (HEL) Joint Technology Office (JTO) and other Services. ***FY 2018 Plans:*** Complete the risk-reduction effort on adaptive optics performance in degraded atmospheric conditions. Validate performance requirements and the initial design of the beam control system (BCS) for the Preliminary Design Review for the next generation High Energy Laser system for an Army platform. This BCS will support an integrated demonstration of a laser weapon system prototype for potential transition into a Program of Record. This applied research on BCS components is part of the HEL technology demonstration. ***FY 2019 Plans:*** Will complete Critical Design Review (CDR) for the BCS for the High Energy Laser Tactical Vehicle Demonstrator (HEL TVD). Will validate performance of a state-of-the-art adaptive optics (AO) subsystem on a test range using the Mobile Beam Control System Integration Laboratory (MBC SIL), a key knowledge point for HEL TVD development. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase is due to development of the High Energy Laser Tactical Vehicle Demonstrator beam control system (BCS). A part of this is increased emphasis on atmospheric compensation and enhanced tracking technologies.	3.645	7.342	18.061
Title: High Efficiency Laser Development ***Description:*** This effort develops component technologies that increase Solid State Laser (SSL) efficiencies, which will lead to reductions in size and weight for multiple subsystems that greatly improve the ability to integrate SSL systems into Army weapon platforms. This work is done in collaboration with the High Energy Laser (HEL) Joint Technology Office (JTO) and other Services. Selected laser design will be fabricated and integrated onto an Army platform to demonstrate a high energy laser system functionality and is fully coordinated with PE 0603004A, Project L96. ***FY 2018 Plans:*** Complete the Preliminary Design Review of the next generation High Energy Laser system for an Army platform which includes validating performance requirements. Complete the majority of the work to hold the Critical Design Review of the laser system.	19.295	10.294	6.170

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602307A / *Advanced Weapons Technology*	**Project (Number/Name)** 042 / *High Energy Laser Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
This laser provides the required power in the size and weight compatible with the selected Army platform for next pre-prototype system demonstration. The laser development is part of the HEL technology demonstration. ***FY 2019 Plans:*** Will complete 100kW laser subsystem build in support of the High Energy Laser Tactical Vehicle Demonstrator (HEL TVD) effort. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decrease is due to the transition from development to for ruggedization of system under 63004/L96. Effort transitioning to Future Vertical Lift laser development. The majority of the laser system development for the High Energy Laser Tactical Vehicle Demonstrator will be completed in FY18.			
Title: HEL Research and Development and Concepts Analysis Laboratories ***Description:*** This effort focuses on developing in-house expertise through Solid State Laser (SSL) assessments and starting in Fiscal Year (FY) 2015, other USASMDC/ARSTRAT technical core competencies, including air and missile defense, responsive space, and small satellites. ***FY 2018 Plans:*** Complete investigation of candidates for suitability for Enhanced Tracking Sensor (ETS) to support the next generation beam control system (BCS). This sensor provides more capable acquisition and track of targets in degraded atmospheric conditions. Select candidate(s) and conduct laboratory level experiments to validate sensor performance satisfies requirements. Begin collecting field data to support model verification. ***FY 2019 Plans:*** Will complete analysis of laboratory level experiments to validate ETS performance against baseline requirements. Will complete collecting field data to support model verification. Will develop initial algorithms for advance adaptive optics. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decrease due to funding shifted from labs to support Future Vertical Lift effort.	1.397	1.475	1.071
Accomplishments/Planned Programs Subtotals	27.766	22.785	29.502

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602307A / *Advanced Weapons Technology*	**Project (Number/Name)** 042 / *High Energy Laser Technology*

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602307A / *Advanced Weapons Technology*	Project (Number/Name) NA5 / *Advanced Weapons Components (CA)*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
NA5: *Advanced Weapons Components (CA)*	-	25.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	25.000

Note

Congressional increase for Program increase

A. Mission Description and Budget Item Justification

Congressional Interest Item funding provided for Advanced Weapons Components applied research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Congressional program increase	25.000	-
FY 2017 Accomplishments: N/A		
Congressional Adds Subtotals	25.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602308A *I Advanced Concepts and Simulation*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	29.767	28.650	28.500	-	28.500	28.765	34.334	36.313	36.189	0.000	222.518
C90: *Advanced Distributed Simulation*	-	19.940	23.223	26.869	-	26.869	27.102	31.365	30.655	29.127	0.000	188.281
D02: *Modeling & Simulation For Training And Design*	-	6.827	5.427	1.631	-	1.631	1.663	2.969	5.658	7.062	0.000	31.237
D14: *Advanced Modeling and Simulation Initiatives (CA)*	-	3.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.000

A. Mission Description and Budget Item Justification

This Program Element (PE) investigates and designs enabling technologies to create effective training capabilities for the Warfighter and supports the underpinning technologies and understanding to establish architecture standards and interfaces necessary for realizing the Army vision of creating a realistic synthetic "electronic battlefield" environment for use across the spectrum of doctrine, organization, training, leader development, materiel, personnel, and facilities (DOTLM-PF). Project C90 focuses on advancing component technologies required for real time interactive linking within and among constructive, virtual, and live simulation and training by refining technologies for advanced distributed interactive simulation. Project D02 further develops concepts for immersive training and learning environments with the Institute for Creative Technologies (ICT) at the University of Southern California, Los Angeles, California.

Work in this PE complements and is fully coordinated with PE 0601104A (University and Industry Research Centers), PE 0602785A (Manpower/Personnel/Training Technology), PE 0602786A (Clothing & Equipment Technology), PE 0602787A (Medical Technology), PE 0603001A (Future Warrior Technology Integration), PE 0603007A (Manpower, Personnel and Training Advance Technology), PE 0603015A (Next Generation Training & Simulation Systems) and PE 0603710A (Night Vision Advanced Technology).

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

Work in this PE is performed by the Army Research, Development, and Engineering Command (RDECOM).

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army	Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602308A *I Advanced Concepts and Simulation*

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	27.688	28.650	35.100	-	35.100
Current President's Budget	29.767	28.650	28.500	-	28.500
Total Adjustments	2.079	0.000	-6.600	-	-6.600
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	3.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.910	-			
• Adjustments to Budget Years	-	-	-6.600	-	-6.600
• FFRDC	-0.011	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: D14: *Advanced Modeling and Simulation Initiatives (CA)*		
Congressional Add: *Congressional Program Increase*	3.000	-
Congressional Add Subtotals for Project: D14	3.000	-
Congressional Add Totals for all Projects	3.000	-

Change Summary Explanation

Congressional increase in D14 Advanced Modeling and Simulation Initiatives.

The FY19 funding reduction occurred to support funding shifts that impact higher priority efforts that align to senior leader priorities for Soldier Lethality and C3I/ Network.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602308A / *Advanced Concepts and Simulation*	Project (Number/Name) C90 / *Advanced Distributed Simulation*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
C90: *Advanced Distributed Simulation*	-	19.940	23.223	26.869	-	26.869	27.102	31.365	30.655	29.127	0.000	188.281

A. Mission Description and Budget Item Justification

This Project investigates and designs enabling technologies for advancing distributed simulation and training (live, virtual and constructive) environments. This includes networking of models representing complex human behavior, complex data interchange between simulations, synthetic natural environments, medical training simulations, ground platform training, adaptive tutoring for individuals and teams, and collaborative training. The Project researches the ability to create a virtual representation of combined arms environments, with the Warfighter-in-the-loop that constructive (event driven) simulations cannot simulate.

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

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

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Live Virtual Constructive Sim & Training ***Description:*** This effort develops and investigates LVC training technologies (tools and methods) to inform an interactive, seamless training environment. Live training refers to personnel and systems performing an exercise mission on real terrain; virtual training refers to personnel using simulators; and constructive training refers to computer based models representing real world behaviors that introduce a wider control of virtual forces. This effort is coordinated with and complements Program Element (PE) 0603015A/Project S29. In Fiscal Year (FY) 18 this effort has been refocused and renamed to Synthetic Natural Environments.	6.396	-	-
Title: Live and Medical Training Technologies ***Description:*** Included in this effort will be the development of new medical training simulations to train medical personnel across all levels of care and the development of live training technology that can be applied across all military levels and training environments. ***FY 2018 Plans:*** Mature sensor and communication components of laser design for the next generation MILES in preparation to conduct experimentation. This research improves the soldier?s live training performance for readiness at Army home station and Combat Training Centers. Investigate accurate representation of simulation and training environments depicting the entire military medical	6.600	6.738	5.965

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*	**Project (Number/Name)** C90 / *Advanced Distributed Simulation*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
population to include, female, pediatric, and elderly, with simulated tissues that change over time based on injury, disease and healing, as well as improving anatomical accuracy by modeling representative patient data. ***FY 2019 Plans:*** Will investigate components such as artificial intelligence algorithms to aid in target recognition, next generation magnetometers, high resolution simulated three dimension terrain and weapon orientation to enhance live training technology research; research in live training technologies will support the Army?s capability need to provide live simulations that accurately replicate and realistically represent the effects of current weapons systems during force-on-force and force-on-target training; design and develop capabilities to improve the accuracy and fidelity of medical simulations for training; investigate and characterize gross and subtle tissue behaviors necessary for higher levels of medical understanding; investigate and develop medical simulation environments that accurately represent the operational environment both inside and outside of the body. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduction in funding as sensor and communication components for the next generation MILES has matured.			
Title: Adaptive Tutoring ***Description:*** This effort investigates adaptive tutoring and immersive learning environments with social simulations to conduct kinetic and non-kinetic training for individuals and teams. ***FY 2018 Plans:*** Conduct experiments to identify opportunities to enhance the capabilities of authoring tools and assess their effectiveness with the goal of reducing authoring times and allowing non-computer programmers the capability to generate sophisticated ITSs; begin to mature and operationalize team tutoring concepts for the Synthetic Training Environments with respect to assessment and interaction between the team and the computer-based tutor. ***FY 2019 Plans:*** Will extend models for individual learners, instructional management, and Army task domains to increase the complexity of adaptive training for individuals to enable future adaptive training; validate a base authoring concept for individual adaptive training; expand concepts for authoring tools, team modeling, team instruction, and Army team domains to support development of team (unit level) tutoring systems; mature training strategies for autonomous software systems; develop recommended systems to reinforce experiential learning of autonomous systems via machine learning techniques. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduction in team tutoring efforts in order to support the acceleration of senior leader priorities for Synthetic Training Environment.	5.744	5.495	2.938
Title: Soldier System Architecture	0.600	1.301	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*	**Project (Number/Name)** C90 / *Advanced Distributed Simulation*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: Research and develop simulation architecture to represent the Soldier as a System considering physiological effects, cognitive load, and Soldier culture in the context of Soldier-materiel interactions supporting training effectiveness, experimentation, and materiel development. The architecture will advance computational strategies to enable the integration and interaction of new and existing Soldier models into a seamless Soldier as a System simulation. This effort is coordinated with and complements PE 0602785/Project 790, PE 0602786/Project H98, PE 0602787/Project 869, PE 0603001/J50, and PE 0603710/ Project K70. ***FY 2018 Plans:*** Develop and mature enhanced simulation representations leveraging emerging Soldier Resilience and Effects of Stress on Shooter Performance study data supporting Soldier Systems Engineering Architecture (SSEA) use case analysis; conduct experiments using developed simulation components in a relevant SSEA operational scenario; and develop additional modeling and simulation (M&S) tools/technologies and Systems Engineering Processes as recommended in the SSEA (M&S) Implementation Plan. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort ends in FY18.			
Title: Training Effectiveness Research ***Description:*** This effort will research and develop simulation architectures, tools, and models that can represent current and future semi and fully autonomous systems. The architecture, tools and models will enable the evaluation of the training impacts (i.e., cognitive, physiological, and team coordination) of future autonomous systems and technologies on individual, crew, and unit tasks. The training demands of systems that are increasingly complex, intelligent, and self-adaptive far exceed those of legacy systems that require training of primarily procedural tasks. This is compounded by parallel increases in autonomy and responsibility at lower echelons. This effort is coordinated with and complements PE 0603015A/Project S29 and 0602716A/ Project H70. ***FY 2018 Plans:*** Mature concepts to optimize training strategies for autonomous systems; and develop recommender system to reinforce experiential learning of autonomous systems via machine learning techniques. ***FY 2019 Plans:***	0.600	1.301	1.400

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*	**Project (Number/Name)** C90 / *Advanced Distributed Simulation*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Will investigate methods and techniques to optimize individual and team training outcomes (cognitive, physiological, physical) for autonomous systems; will extend development of techniques to improve recommender systems that will maximize training for teams using complex, adaptive, and intelligent autonomous systems. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding increase in methods and techniques to optimize individual and team training to support senior leader priorities for Synthetic Training Environment.			
Title: Rapid Soldier Capability Enhancement - Training ***Description:*** Research the relationship of augmentation agents and Soldier performance & behavior. Investigate the effects of augmentation agents (perceptual, cognitive, and/or physical), used either individually or coupled as a system of agents, on Soldier performance, resilience, and training during operationally relevant tasks. Development of guidelines and models for designing and employing augmentation agents. Implementation of guidelines will enhance augmented Soldier performance. This research is coordinated with PE 0602716A/Project H70. ***FY 2018 Plans:*** Investigate augmentation application, including timing, amplitude, and duration relative to biological and environmental signals, to understand functionality in varied and complex environments. Model performance and adaptation to augmentation agents in order to predict capability enhancement; investigate individual variability and short and long term adaptation to augmentation agents. Explore the extension of methods and metrics developed for single augmentation agent to the quantification of Soldier performance while using a system of augmentation agents. ***FY 2019 Plans:*** Will explore augmentation technologies with potentially broad applications, to include adaptive training applications to increase Soldier performance and reduce time-to-proficiency in mounted and dismounted Soldier tasks; will investigate novel approaches for integrating advanced metrics of factors related to individual variability into adaptive training technologies to enable augmentation techniques in complex training applications. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding reduction to support other research investments supporting senior leader priorities for Synthetic Training Environment.	-	2.184	2.178
Title: Synthetic Natural Environments ***Description:*** This effort investigates and develops tools and methods to improve the speed, fidelity and delivery of synthetic terrain and environmental data to support Training Aid Devices (TADs), simulation and mission rehearsal systems. This effort is coordinated with and complements PE 0603015A/Project S28.	-	6.204	2.260

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*	**Project (Number/Name)** C90 / *Advanced Distributed Simulation*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2018 Plans: Investigate physics-based dynamic algorithms and terrain components in a cloud based computing environment for the Army? s One World Terrain representation. This research provides environment representation in order to deliver training in mission rehearsal for soldiers at the point of need. ***FY 2019 Plans:*** Will research in synthetic natural environments supports the Army capability need to rapidly and accurately collect, develop, digitize, store, and access detailed terrain information from a single correlated terrain database that is easily scalable from soldier level to global level views of the world. This is part of the Army future synthetic training environment and One World Terrain representation; will develop dynamic terrain /updates that dynamically change the synthetic environment based on simulated and real world events; will investigate data exploitation and advanced rendering techniques for geospatial data at runtime to produce realistic human interactions; will research advanced synthetic generation techniques as to the scalability required for detail and quantity needed for complete data/content coverage of the globe. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduction in funding that supports rendering techniques for geospatial data in order to support the acceleration of Synthetic Training Environment efforts.			
Title: Mixed Reality Research ***Description:*** This effort investigates and develops enabling virtual and augmented reality simulation and training technologies to support future training environments and U.S Army senior leader initiatives in Decide Faster, Asymmetric Vision, and Manned-Unmanned Teaming capabilities. These technologies support the Army capability needs for enhanced dismounted Soldier performance in complex urban environments. Identification of future technologies will be done in concurrence with the core modeling and simulation enablers for megacities. ***FY 2019 Plans:*** Will examine how interfaces for virtual training systems affect user interactions with those systems and thereby impact training and performance outcomes; will examine how different interfaces for virtual training systems can be used to more seamlessly integrate live and virtual training to improve training transfer from virtual to live; will investigate and design the synthetic framework, architecture, and technologies to enable a manned/unmanned teaming training and rehearsal simulation environment. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Investment supports senior leader priorities for Soldier Lethality and Synthetic Training Environment.	-	-	4.146
Title: Cyber for Training Simulations	-	-	2.800

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*	**Project (Number/Name)** C90 / *Advanced Distributed Simulation*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: This effort investigates and develops analytical capabilities to more accurately characterize, model, and predict human behavior related to Cyber Electromagnetic Activities (CEMA) events from the tactical to the strategic level. ***FY 2019 Plans:*** Will investigate analytical capabilities and methodologies for generating models from empirical data and social and psychological theory to describe CEMA-related human attributes (e.g., intent, posture, and capability); and will design initial simulation environment integrating new human models with existing and developing CEMA representations. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Investment supports senior leader priorities for Soldier Lethality and Synthetic Training Environment.			
Title: Artificial Intelligence ***Description:*** This effort investigates artificial intelligence techniques to develop intelligent, human-like, virtual characters to maximize and accelerate Soldier learning in future simulation and training applications. This effort also develops novel methods for joint human/intelligent agent learning and decision making. ***FY 2019 Plans:*** Will investigate capabilities for data mining to better predict individualized degradation in task performance after completion of training; and design initial capabilities for identifying appropriate training resources to mitigate this degradation using individualized intelligent training technologies. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Investment supports senior leader priorities for Soldier Lethality and Synthetic Training Environment.	-	-	1.500
Title: Synthetic Training Environment Acceleration ***Description:*** This effort designs and develops technologies that will transition to advanced technology development in order to enable a Synthetic Training Environment which is a single, interconnected training system in which units from squad through ASCC can train in the most appropriate domain - live, virtual, constructive, and gaming, or in all four simultaneously. ***FY 2019 Plans:*** Will mature AI representation of simulated forces to model relevant aspects of the Multi Domain Battle (MDB), increase simulated entity scalability and increase concurrent role-players to enable synthetic collective training; investigate the automated generation of high fidelity synthetic natural environment data in support of the Army?s future synthetic training environment global terrain requirement; determine techniques to automate the attribution of terrain, procedurally extract building extents and apply surface features utilizing point cloud, texture, crowd-sourced and other emerging sources of data; design and develop terrain resolution	-	-	3.682

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*	**Project (Number/Name)** C90 / *Advanced Distributed Simulation*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
algorithms which encompass the ability to embed Human Terrain (cultural attributes, infrastructure, social media) in the synthetic environment. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort will support the acceleration of Synthetic Training Environment efforts in support of senior leader priorities for Soldier Lethality.			
Accomplishments/Planned Programs Subtotals	19.940	23.223	26.869

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602308A / *Advanced Concepts and Simulation*	Project (Number/Name) D02 / *Modeling & Simulation For Training And Design*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
D02: *Modeling & Simulation For Training And Design*	-	6.827	5.427	1.631	-	1.631	1.663	2.969	5.658	7.062	0.000	31.237

A. Mission Description and Budget Item Justification

This Project transitions basic research into applied research. This Project investigates and designs training applications to enable the Army to train any time and any place. Efforts include designing virtual humans that embody natural language, speech recognition in noisy environments, gesture, gaze, and conversational speech. Techniques and methods are assessed for integrating different sensory cues into virtual environments that result in enhanced training and leader development. The project leverages the capabilities of industry and the research and development community through the synthesis of creativity and technology, including work at the Army Research Institute and the Army Research Laboratory.

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

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

The cited work is consistent with the S&T priorities of the U.S. Army Chief of Staff, Assistant Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Immersive Technology Environments	3.414	2.714	1.100
Description: Conduct applied research that enables responsive and reconfigurable environments that immerse human senses such as sight, sound, and touch in mixed reality environments to include physical elements providing touch and feel to simulate objects such as obstacles and walls.			
FY 2018 Plans: Develop technologies that enable the study of learning and engagement on mobile devices (e.g., smartphones) which are a key platform for future learning technology; develop cloud-based toolkit for recording, analyzing, and adapting to learner engagement and other emotions for both web-based and mobile platforms; and develop tools and processes to ease the authoring and deployment of conversational virtual coaches across multiple computing platforms to include import/export, integration, and debugging features.			
FY 2019 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*	**Project (Number/Name)** D02 / *Modeling & Simulation For Training And Design*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Will utilize brain imaging studies, such as MRI, to identify specific regions and networks of the brain affected by virtual reality, related to empathy and decision making which will help reveal neurological mechanisms of how virtual reality can aid military personnel in making better decisions. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduction in cloud-based toolkit investments to support senior leader priorities for Soldier Lethality and Synthetic Training Environment.			
Title: Immersive Technology Techniques ***Description:*** This effort develops tools, techniques and technologies for improving the immersion of human senses within simulation environments and therefore creating enhanced realism. ***FY 2018 Plans:*** Conduct empirical studies to better understand perceptual mechanisms and design parameters that are important for multi-user virtual reality environments; and develop, integrate, and demonstrate enhanced automated language computer processing techniques for translating real-world narratives into authorable interactive narratives for immersive simulations. ***FY 2019 Plans:*** Will conduct research to enable Soldiers to train in simulated environments using applied research to provide technology options for development and transition. These technologies derived from this research will address the complex operational environment elements and multi-domain interactions in order to provide accelerated, adaptable, flexible, and sustained unit readiness for the full range of Army missions. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduced investment in automated language computer processing techniques in order to support senior leader priorities for Soldier Lethality and Synthetic Training Environment.	3.413	2.713	0.531
Accomplishments/Planned Programs Subtotals	6.827	5.427	1.631

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602308A / *Advanced Concepts and Simulation*	**Project (Number/Name)** D02 / *Modeling & Simulation For Training And Design*

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602308A / *Advanced Concepts and Simulation*	Project (Number/Name) D14 / *Advanced Modeling and Simulation Initiatives (CA)*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
D14: *Advanced Modeling and Simulation Initiatives (CA)*	-	3.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	3.000

Note

Congressional increase

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for applied research in Advanced Modeling and Simulation.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Congressional Program Increase	3.000	-
FY 2017 Accomplishments: N/A		
Congressional Adds Subtotals	3.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602601A / *Combat Vehicle and Automotive Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	89.852	67.232	70.450	-	70.450	69.169	75.717	74.564	76.019	0.000	523.003
C05: *Armor Applied Research*	-	22.842	21.428	21.492	-	21.492	17.205	17.141	17.924	18.259	0.000	136.291
H77: *National Automotive Center*	-	15.347	17.977	12.094	-	12.094	12.423	14.929	15.288	15.594	0.000	103.652
H91: *Ground Vehicle Technology*	-	26.663	27.827	36.864	-	36.864	39.541	43.647	41.352	42.166	0.000	258.060
T31: *NAT'L AUTO CENTER APP RES INIT (CA)*	-	25.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	25.000

A. Mission Description and Budget Item Justification

This Program Element (PE) researches, designs, and evaluates combat and tactical vehicle automotive technologies that enable the Army to have a lighter, more survivable, more mobile and more deployable force. Project C05 investigates, researches, and evaluates advanced ground vehicle design and occupant protection technologies in such areas as armor concepts, ballistic defeat mechanisms, blast mitigation, survivability modeling and simulation (M&S), hit avoidance, kill avoidance, safety, sensors, counter-measures, instrumentation, and survivability packaging concepts to achieve superior survivability/protection for Soldiers and military ground vehicles. Survivability technologies will be designed for integration into/with the Modular Active Protection System (MAPS). Project H77 funds the National Automotive Center (NAC), which was chartered by the Secretary of the Army to conduct shared government and industry, or "dual use", technology programs to leverage commercial investments in automotive technology research and development for Army ground combat and tactical vehicle applications. Project H91 designs, matures, and evaluates a variety of innovative and enabling technologies in the areas of electrical power, thermal management, propulsion, mobility, power for advanced survivability, vehicle diagnostics, fuels, lubricants, water purification, intelligent systems, autonomy-enabled systems, and other component technologies to enhance the mobility, power and energy, and reduce the logistic chain of combat and tactical vehicles. This PE executes the Army's Combat Vehicle Prototyping (CVP) program to mature, integrate, and demonstrate ground vehicle leap ahead technologies in support of future combat vehicles.

Work in this PE is related to, and fully coordinated with, PEs 0602105A (Materials Technology), 0602618A (Ballistics Technology, Robotics Technology), 0602705A (Electronics and Electronic Devices), 0602716A (Human Factors Engineering Technology), 0603005A (Combat Vehicle and Automotive Advanced Technology), 0603125A (Combating Terrorism - Technology Development), 0603734 (Military Engineering Advanced Technology), and 0708045A (Manufacturing Technology).

Work in this PE is coordinated with the United States Marine Corps, the Naval Surface Warfare Center, and other ground vehicle developers within the Defense Advanced Research Projects Agency (DARPA) and the Departments of Energy, Commerce, and Transportation.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy in New combat vehicle, Armor, Robotics/Autonomy.

The Ground Portfolio technology investments are creating a layered vehicle protection suite including Active Protection (Hard-Kill and Soft-Kill) capabilities supported by robust advanced armor (Enhanced Survivability).

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army	Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602601A *I Combat Vehicle and Automotive Technology*

Work in this PE is performed by the Army Research Development and Engineering Command (RDECOM)

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	67.959	67.232	68.826	-	68.826
Current President's Budget	89.852	67.232	70.450	-	70.450
Total Adjustments	21.893	0.000	1.624	-	1.624
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	25.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-2.475	-			
• Adjustments to Budget Years	-0.601	-	1.624	-	1.624
• FFRDC	-0.031	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: T31: *NAT'L AUTO CENTER APP RES INIT (CA)*		
Congressional Add: *Program Increase - Alternative Energy Research*	15.000	-
Congressional Add: *Program increase*	10.000	-
Congressional Add Subtotals for Project: T31	25.000	-
Congressional Add Totals for all Projects	25.000	-

Change Summary Explanation

FY17 Congressional increase in T31 Nat'l Auto Center App Res Init

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / *Combat Vehicle and Automotive Technology*	Project (Number/Name) C05 / *Armor Applied Research*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
C05: *Armor Applied Research*	-	22.842	21.428	21.492	-	21.492	17.205	17.141	17.924	18.259	0.000	136.291

A. Mission Description and Budget Item Justification

This Project investigates, researches, and evaluates advanced ground vehicle design and occupant protection technologies in such areas as armor concepts, ballistic defeat mechanisms, blast mitigation, survivability modeling and simulation (M&S), improved situational awareness, hit avoidance, kill avoidance, safety, sensors for blast, crash and rollovers, instrumentation and survivability packaging concepts to achieve superior survivability/protection for Soldiers and ground combat and tactical vehicles. Survivability/protection technologies are being investigated to meet anticipated ground combat and tactical vehicle survivability objectives. Additionally, this project focuses on analysis, modeling, and characterization of potential survivability solutions that could protect against existing and emerging threats. This analysis is used to aid in the identification of technologies to enter maturation and development in Program Element (PE) 0603005A, Project 221.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Advanced Armor Development:	9.682	11.025	9.942
Description: The objective of this effort is to design, integrate and validate performance of advanced armor systems to defeat single and multiple chemical energy (CE) and kinetic energy (KE) emerging threats for combat and tactical vehicles. These systems include base armor (small arms / medium caliber, opaque and transparent B-kits), applique armor (passive / reactive / active multi-threat C-kits), multifunctional armor, and adaptive and cooperative armors. This effort coordinates with PEs 0602618A and 0603005A.			
FY 2018 Plans: Mature attachment designs for subsystem integration of advanced passive and reactive armor technologies; verify performance of subsystem integration design for advanced passive and reactive armor technologies through finite element modeling; investigate various adaptive armor solutions in relevant environment; begin the design of adaptive armor subsystem for system integration.			
FY 2019 Plans: Will mature design of adaptive armor subsystem for system integration; will complete experiments on system attachments to validate component integration; will use the integration experiment results to identify and design the desired attachment approach for follow-on integration of those technologies; will verify performance of subsystem integration design for adaptive armor			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** C05 / *Armor Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
technologies through experimentation and finite element modeling; will begin design and development of hybrid multi-threat armor subsystem. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduction in design time resulting in reduced need for program funding			
Title: Blast Mitigation: ***Description:*** This effort designs, fabricates and evaluates advanced survivability and protection capabilities, tools and technologies to improve protection against vehicle mines, improvised explosive devices (IEDs) and other underbody threats and crash events. This effort also designs and evaluates technologies purposed for protecting the occupant such as seats and restraints. Blast and crash mitigation technologies are further investigated and matured in such areas as active and passive exterior/hull/cab/kits, interior energy absorbing capabilities for seats, floors, restraints, sensors for active blast mitigating technologies and performance evaluation, modeling and Simulation (M&S), experimentation and instrumentation. This effort coordinates with PEs 0602618A and 0603005A. ***FY 2018 Plans:*** Designing subsystem concepts for integration of armor and Modular Active Protection System (MAPS) surrogate hardware; validate design of subsystem components required for integration of seats, restraints, flooring and structures through structural and blast analysis; mature WIAMan certification test procedures based on test results. ***FY 2019 Plans:*** Will develop and document best practices (multi-material, cost-conscious, lightweight design) for optimization of structural subsystem technologies that will provide platform ballistic protection. Will complete individual component performance testing of seats, restraints, flooring, and structures. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduction in Experiment time	2.734	2.932	2.557
Title: Synergistic Vehicle Protection Technologies: ***Description:*** This effort investigates and integrates advanced synergistic survivability technologies and simulation tools to provide enhanced protection for ground vehicles while minimizing overall system burdens. Synergistic survivability technologies such as, armor and active protection, offer the potential of non-linear survivability improvements. The modular approach facilitates trade-offs between protection, payload, performance, cost drivers and performance of vulnerability assessments throughout the life cycle of a system. Provides quantifiable metrics for development of requirements and evaluation of concept feasibility in the development of survivable combat systems.	2.002	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** C05 / *Armor Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Improved Situational Awareness for Ground Platforms	6.842	5.608	4.615
Description: This effort investigates situational awareness (SA) technologies and architectures to improve occupant and vehicle survivability in all conditions and environments to include degraded visual environments (DVE) for ground vehicles. This effort also investigates and analyzes electronic architectures to enable the efficient integration of DVE systems such as intra-vehicle data and video networks, SA input/output devices, and associated software architectures and interfaces. This effort coordinates with PEs 0603005A, 0602709A, and 0603710A. ***FY 2018 Plans:*** Validate increased SA in DVE to enable indirect vision driving maneuverability, driving aids to reduce accidents & threat detection to improve survivability. Improve operational tempo (OPTEMPO) in DVE to maintain OPTEMPO and decrease occupant injury. Optimize aviation capabilities provided by the Degraded Visual Environment Mitigation (DVE-M) program to provide a complete sensor that is scalable to the mission and vehicle family. ***FY 2019 Plans:*** Will mature increased local SA components in DVE using scalable low cost Local Situational Awareness (LSA) sensors and a digital video architecture system. Will investigate advanced vehicle crew stations with scalable Warfighter-Machine Interface (WMI), augmented reality and crew aids. Will conduct experiments to validate decreased visual latency, increased SA, increased target detection, and increased OPTEMPO in DVE. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduction in hardware needed for experimentation			
Title: Vision Protection	1.582	1.863	-
Description: This effort investigates and develops protection materials, concepts, and devices to protect vehicle occupants' eyes, vehicle cameras and electro-optical fire control systems against emerging laser threats. This effort also evaluates methods to apply the advanced protection materials, concepts, and devices onto vehicle cameras and electro-optical systems to prevent lasers from destroying sighting systems, disabling cameras that provide situational awareness, and damaging or disorienting Warfighter vision. Coordinated work is also being performed in PEs 0602120A, 0602705A, 0602712A and 0603005A. ***FY 2018 Plans:*** Conduct experiments to mature protected day cameras for near-term threat protection; design and mature concepts for future systems to protect against current and future laser threats; improve laboratory capability to enable integration and testing of vision protection concepts on ground vehicles. ***FY 2018 to FY 2019 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** C05 / *Armor Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
This effort is ending in FY 18 to adjust for other higher priority efforts			
Title: Protection for Autonomous Systems ***Description:*** This effort investigates and develops materials, concepts, and devices to protect autonomous systems against emerging threats. This effort also evaluates methods to apply the advanced protection materials, concepts, and devices onto autonomous systems to prevent disabling or destroying sensors, electronics, and mechanical components, or physical exploitation of subsystems. This effort coordinates with PEs 0602618A and 0603005A. ***FY 2019 Plans:*** Will investigate concepts for protection of autonomous systems in forecasted operational environments. Will identify technologies that address projected threats and hazards. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** New Start program	-	-	2.500
Title: Active Defense Technologies ***Description:*** This effort investigates, analyzes, and designs active hard-kill (physical countermeasure) and soft-kill (non-kinetic countermeasure such as electronic jamming or spoofing) protection Active Protection System (APS) components for future integration onto tactical and combat vehicle platforms. This effort also investigates, designs, and development active, modular components and controls for APS vehicle protection and associated architectures and interfaces. This effort is coordinated with efforts in PEs 0602601A, 0602618A, 0603004A, 0603270A, 0603313A, and 0604115A. ***FY 2019 Plans:*** Will investigate and analyze future hard-kill and soft-kill active defense concepts for use with combat vehicles. Will investigate and design modular components according to architecture and interface requirements. Will develop and assess advanced soft-kill technologies that will defeat higher-level and emerging threats. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** New Start program	-	-	1.878
Accomplishments/Planned Programs Subtotals	22.842	21.428	21.492

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** C05 / *Armor Applied Research*

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / *Combat Vehicle and Automotive Technology*	Project (Number/Name) H77 / *National Automotive Center*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H77: *National Automotive Center*	-	15.347	17.977	12.094	-	12.094	12.423	14.929	15.288	15.594	0.000	103.652

A. Mission Description and Budget Item Justification

This Project funds the National Automotive Center (NAC), which was chartered by the Secretary of the Army to conduct shared government and industry (dual use) technology programs to leverage commercial investments in automotive technology research and development for Army ground combat and tactical vehicle applications. Primary thrusts for this activity include advanced power and energy technologies for tactical and non-tactical ground vehicles, electric infrastructure and alternative energy for installations and bases, vehicle networking and connectivity to maximize overlap between commercial and military requirements. Active outreach to industry, academia and other government agencies develops new thrust areas for this Project to maximize shared commercial and government investment.

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

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy in New Combat Vehicle, Armor, Robotics/Autonomy. The Ground Portfolio technology investments are maturing powertrain technologies to provide a fuel efficient engine/powerplant capability that is common across the fleet to reduce fuel, training, maintenance and parts requirements.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Power, Energy and Mobility:	4.017	4.391	4.410
Description: This effort investigates dual use power, energy, and mobility technologies leveraging commercial and academic investment to military application. This effort focuses on technologies such as lightweight composite materials, electrification of engine accessories, alternative fuels, hybrid vehicle architectures, and compact electrical power generation in order to maximize common investment to meet Army ground vehicle requirements. This work is done in conjunction with Program Elements (PEs) 0603005A and 0603125A.			
FY 2018 Plans: Continue to investigate new computer-aided engineering tools for vehicle batteries that can accurately predict the combined structural, electrical, and thermal responses to military usage conditions. Continue to investigate new computer-aided engineering tools for vehicle engines that accurately model fuel injection spray, cavitation within fuel injectors, flash boiling, spray/wall interaction, super critical fuel injection, in-cylinder radiation and heat transfer, engine knock and soot emissions. Continue to investigate alternate integrated starter generator motors that achieve the required power and torque densities without Rare-Earth materials. Continue to collaborate with automotive industry and Department of Energy in fuel cell technology maturation.			
FY 2019 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H77 / *National Automotive Center*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Will continue to leverage commercial and academic investments into dual use power, energy, and mobility technologies. Will investigate advances in battery design and safety. Will conduct fuel-cell experimentations, in order to mature component designs, and investigate alternative base fuels. Will research into electrification of parasitic powertrain and vehicle loads that promise weight savings in addition to more efficient use of onboard power. Will identify feasible material options to reduce weight and \or increase structural integrity which would improve mobility in areas such as: aluminum, composites, joining technologies, and design optimization. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Slight increase in needed funding from FY 18 to FY 19 results primarily from an anticipated increased need of investigation in battery design.			
Title: Dual Use Technologies: ***Description:*** This effort investigates, researches and evaluates ground vehicle technologies with both military and commercial applications such as renewable energy technologies, electrical power management between vehicles and the grid, alternative fuels, new human machine interfaces, and advanced vehicle networking, automation, and secure communication (telematics). This effort maximizes commercial technology investment for military applications in line with the National Automotive Center's Charter. Collaborations with industry, universities and other government agencies on standards writing for joint applications will facilitate this activity. This work is done in conjunction with PE 0603005A. ***FY 2018 Plans:*** Continue to leverage commercial automotive and trucking research and development centers to transition reliable, affordable technology solutions to our military ground vehicle fleet. Continue dual use collaborative investigations of military & commercial ongoing open vehicle architecture standards, electrification standards, autonomous systems technologies and integration, vehicle security engineering best practices, and communication systems integration challenges through collaborative mechanisms such as the Society of Automotive Engineers, Automation Alley, the Center for Automotive Research (CAR), and the HTUF. Conducting integration of autonomy systems on international vehicles and demonstrate an autonomous convoy with advanced vehicle behaviors. ***FY 2019 Plans:*** Will research ground vehicle technologies with both military and commercial applications. Will conduct experiments with innovative human machine interfaces, advanced vehicle networking, and vehicle automation technologies. Will focus on vehicle security engineering best practices that prevent detriment to crew and vehicles from cyber-attacks. Will research of autonomy systems on coalition international vehicles. Will further the advancement of tactics, training, and procedures (TTPs) for inclusion of	11.330	13.586	7.684

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H77 / *National Automotive Center*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
autonomous systems and studies on vehicle networking and cyber security. Will mature concepts to increase logistics fleet affordability and reduce logistics footprint through autonomy. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Ending National Automotive Center (NAC) investment in vehicle architecture and electrification standards.			
Accomplishments/Planned Programs Subtotals	15.347	17.977	12.094

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / *Combat Vehicle and Automotive Technology*	Project (Number/Name) H91 / *Ground Vehicle Technology*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H91: *Ground Vehicle Technology*	-	26.663	27.827	36.864	-	36.864	39.541	43.647	41.352	42.166	0.000	258.060

A. Mission Description and Budget Item Justification

This Project designs, develops, and evaluates a variety of innovative enabling technologies in the areas of vehicle concepts, virtual prototyping, electronic controls, electrical power, thermal management, propulsion, mobility, survivability, vehicle diagnostics, fuels, lubricants, water purification, intelligent systems, autonomy-enabled systems, and other component technologies for application to combat and tactical vehicles.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Pulse Power:	3.568	-	-
Description: This effort focuses on growing compact, high frequency/high energy/high power density components and devices for several advanced electric-based survivability and lethality weapon systems. Technologies include direct current (DC) to DC chargers, high energy batteries, pulse chargers, high density capacitors, and solid state switches. This effort is coordinated with Program Elements (PEs) 0603005A and 0602705A.			
Title: Propulsion and Thermal Systems:	5.895	6.466	5.995
Description: This effort researches, designs and evaluates high power density engines and transmission systems needed to offset increasing combat vehicle weights (armor), improved fuel economy (fuel cost & range), and reduced cooling system burden (size, heat rejection). This effort also researches and matures thermal management technologies and systems including heat energy recovery, propulsion and cabin thermal management sub-systems to utilize waste heat energy and meet objective power and mobility requirements on all ground vehicles. Lastly, this effort maximizes efficiencies within propulsion and thermal systems to reduce burden on the vehicle while providing the same or greater performance capability. This effort is coordinated with PE 0603005A.			
FY 2018 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 / *Ground Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Mature advanced heat exchanger, efficient fan, and waste heat recovery system into advanced thermal management system. Mature advanced thermal management system concept design in preparation of integration into advanced combat vehicle propulsion system. ***FY 2019 Plans:*** Will conduct experiments on advanced heat exchanger, efficient fan, and waste heat recovery system in the advanced thermal management system. Will validate advanced thermal management system design. Will improve the component and system design based on test results. Will complete subsystem testing of high power density engine and transmission. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduction in experiments			
Title: Power Management Technologies: ***Description:*** This effort investigates power management technologies, software, and implementation approaches. Technologies include Alternating Current (AC) to Direct Current (DC) inverters, DC-DC converters, solid state circuit protection, power distribution, and automated control of complete power systems. Special emphasis has been placed on developing high temperature capable power electronics, leading to the use of Silicon Carbide (SiC) in the above technologies. This effort coordinates with PE 0603005A. ***FY 2018 Plans:*** Complete testing of Gallium Nitride (GaN) and SiC based leap-ahead electrical power system in the SIL to troubleshoot issues in preparation for future combat vehicle integration. Continuing environmental, EMI, reliability performance, and other testing of vehicle power architecture system components and software to prepare for future combat vehicle testing. ***FY 2019 Plans:*** Will validate power architecture control software functionality in order to confirm power quality, prioritization and optimization algorithms that maximize available power on the vehicle. Will validate environmental, EMI, reliability performance, and other testing of high operating temperature vehicle power architecture system Silicon Carbide components and software to ensure readiness for future combat vehicle testing. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduced due to less experimentation needed	2.225	2.685	2.671
Title: Power Electronics, Hybrid Electric and Onboard Vehicle Power (OBVP) Components: ***Description:*** This effort researches, develops and evaluates technologies to increase onboard vehicle electric power to enable vehicle systems such as advanced survivability systems, situational awareness systems, advanced computing, and the Army network. This effort researches, designs and evaluates high temperature and efficient power generation components to provide	1.488	0.750	0.318

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 / *Ground Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
increased electrical power and reduced thermal loads using high operating temperature switching devices and advanced electrical generation components such as integrated starter generators and integrated starter alternators. This effort also researches, designs and evaluates advanced control techniques for power generation components to make these systems more efficient, increase electrical power output and reduce thermal loads. This effort is coordinated with PE 0603005A. ***FY 2018 Plans:*** Complete testing of integrated starter generator system in brass board configuration. Begin analysis and system design optimization on an advanced combat vehicle propulsion system. ***FY 2019 Plans:*** Will complete analysis and system design optimization on an advanced combat vehicle propulsion system. Will evaluate the increase in onboard vehicle power availability and fuel efficiency with no negative impact to vehicle mobility. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduction in needed components for experimentation			
Title: Advanced Non-Primary Power Systems: ***Description:*** This effort researches, investigates, conducts experiments and validates Auxiliary Power Units (APUs) technologies such as modular/scalable engine based APUs, fuel cell reformer systems to convert JP-8 to hydrogen, sulfur tolerant JP-8 fuel cell APUs and novel engine based APUs for military ground vehicle and unmanned ground systems. This effort also determines inputs for APU interface control documents, as well as investigates solutions for reducing APU acoustic signature for silent operation during mounted surveillance missions. This effort investigates the use of small engines and JP-8 fuel cell systems for use as prime power solutions for unmanned ground systems. ***FY 2018 Plans:*** Investigate advanced APU to verify performance, control strategy and advanced noise control. Continue to optimize active noise cancellation, isolation and muffling to decrease auditory detection during mounted surveillance missions. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Ending work in Advanced Non-Primary Power Systems as a result is priority adjustments	1.398	1.327	-
Title: Elastomer Improvement Program: ***Description:*** This effort researches, formulates and tests new elastomer (rubber) compounds for vehicle track systems to increase track system durability, reduce track system failures and reduce Operations & Sustainment (O&S) costs related to premature track system failures.	0.265	0.662	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 / *Ground Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2018 Plans: Formulate final compounds for selection and inclusion on the advanced running gear demonstration platform. Mold compounds for the track pad, bushing and road wheels. Perform final laboratory evaluations on selected finished product compounds and then produce quantity for demonstrator evaluations. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Program ending			
Title: Intelligent Systems Technology Research: ***Description:*** This effort investigates improved operations of manned platforms through the application of sensing and autonomy technologies developed for unmanned systems such as maneuver and tactical behavior algorithms, driver assist techniques, autonomy kits, advanced navigation and planning, vehicle self-protection, local situational awareness, advanced perception, vehicle and pedestrian safety, active safety, and robotic command and control. This effort is coordinated with efforts in PEs 0602120A, 0602784A, 0603005A, and 0603734A. ***FY 2018 Plans:*** Continue to design and develop the Warfighter Machine Interface for scalability and driver/crew aids. Mature the increased reliability of robotic technologies to produce trust and confidence of autonomous vehicles. Improve standardized data collection tools and methodologies to mature Department of Defense (DoD) ground robotic requirements, development, technology investments and procurement decisions. Conduct experiments to validate that these tools and technologies are increasing our capabilities of protecting the force, reducing burden on soldiers, and mission command & tactical intelligence. ***FY 2019 Plans:*** Will develop advanced vehicle behaviors to transition to autonomy-enabling kits for tactical wheeled vehicles in leader-follower convoy operations. Will continue to develop and design common user interfaces and open architecture design. Will continue to research automation software and algorithms, increased robotic reliability and autonomous testing methodologies and procedures. Will continue to advance capabilities to enable operations in increasingly challenging environments like off-road terrain and reduced communication areas. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Hardware components needed for experimentation account for increased costing	9.350	9.917	10.005
Title: Energy Storage: ***Description:*** This effort investigates novel advanced ground vehicle energy storage devices such as advanced chemistry batteries and ultra capacitors for starting, lighting, and ignition and silent watch requirements for powering vehicle electronics and communications systems with main engine off. Develop and test energy storage devices to meet harsh military requirements that	2.474	2.520	2.536

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 / *Ground Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
far exceed commercial requirements such as extreme temperature operation (-46 to +71C), ballistic shock and vibration, and electromagnetic interference (in accordance with MIL-STD-810G). Designs and develops advanced batteries to reduce battery volume and weight while improving battery energy and power densities within the same footprint and standardized form factor of current batteries (6T) to enhance logistics. ***FY 2018 Plans:*** Complete design and mature battery cells into modules. Design and mature battery packs built around the modules. Conduct durability and performance testing at the module level for advanced Li-ion chemistries. ***FY 2019 Plans:*** Will conduct durability and performance experimentation at the battery pack level for advanced Li-ion chemistries to validate improved energy density, starting, lighting, propulsion system ignition, silent watch, reliability, battery safety management, for military vehicles. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** increase due to Inflation			
Title: Anti-Tamper ***Description:*** This effort investigates and develops mature anti-tamper methodologies and technologies in combat and tactical vehicles. Technologies such as controllers and tactical information systems for autonomous appliques, active protection systems, and Command, Control, Communications, Computers & Intelligence (C4I), will be designed for enhanced protection against current and evolving threats. This includes: enhancing and defending technologies used to secure data in vehicle systems; defending against the threat of unwanted behavioral changes in multi-agent systems; the prevention of unauthorized control of, or denying service to a targeted platform; reverse engineering and conducting vehicle digital forensics; and responding to active attacks that have penetrated anti-tamper defenses in a platform. ***FY 2018 Plans:*** Develop measurement, analysis and verification methods to identify vulnerabilities of combat and tactical vehicle software-based technologies; capitalize on currently available virtual (Modeling & Simulation) toolsets to design and ?virtually? conduct experiments of potential safeguards and solutions of the vehicle architecture, and begin to evaluate methods and toolsets on ground vehicle hardware. Investigate applications of anti-tamper that are applicable to both current and future vehicles. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Program ending	-	3.500	-
Title: Crew Station	-	-	4.775

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 / *Ground Vehicle Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: This effort focuses on crew size reduction and crew stations tailored to mission and soldier needs through the utilization of emerging human-interaction technologies, automations, machine intelligence and the provision of cohesive domain personalization to permit soldiers to achieve leap-ahead performance beyond today?s constrained ground vehicle environment. ***FY 2019 Plans:*** Will conduct experiments to provide data to improve early warning detections, reduce response times and shorten task durations for future crewstation programs. Will investigate crew size reduction to determine if the same overall performance can be produced by performing simulations to provide data, reports and analysis to the future fighting vehicles. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** New Start that is aligned with Next Generation Combat Vehicle crew station			
Title: Unmanned Ground Systems Research ***Description:*** This effort researches, designs, and develops technologies that enable scalable integration of multi-domain teamed robotic and autonomous system capabilities supporting Army combat formations. Investigate behaviors and algorithms to mature functions that detect and classify risks and threats, reduce burden on the Soldier operator, and validate initial safety procedures for armed Unmanned Ground Vehicles (UGVs) in contested, austere and congested environments. Investigates increased situational awareness needed for a high degree of survivability and lethality for complex maneuvers. Mature government-owned autonomy architecture to enable iterative software capability upgrades for systems. Conduct experiments in static environment with multiple live and simulated manned-unmanned vehicles with evolving threats. Investigate behaviors and hardware needed to rapidly learn, adapt & reason faster than the adversary. This effort is coordinated with efforts in PEs 0602120A, 0602784A, 0603005A, and 0603734A. ***FY 2019 Plans:*** Will investigate vehicle behaviors to enable teamed robotic and autonomous systems to support specific capabilities supporting Army combat formations. Will research and design common user interfaces for remote lethality with limited targeting assist. Will research automation software and algorithms, increased robotic reliability and function, and determine certified safety procedures for soldier-operated armed UGVs. Will conduct experiments using various commercial network solutions. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding was initiated in FY 19 for Combat Vehicle Robotics acceleration.	-	-	10.564
Accomplishments/Planned Programs Subtotals	26.663	27.827	36.864

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602601A / *Combat Vehicle and Automotive Technology*	**Project (Number/Name)** H91 / *Ground Vehicle Technology*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602601A / *Combat Vehicle and Automotive Technology*	Project (Number/Name) T31 / *NAT'L AUTO CENTER APP RES INIT (CA)*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
T31: *NAT'L AUTO CENTER APP RES INIT (CA)*	-	25.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	25.000

Note

Congressional increases

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for National Automotive Center applied research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Program Increase - Alternative Energy Research ***FY 2017 Accomplishments:*** N/A	15.000	-
Congressional Add: Program increase ***FY 2017 Accomplishments:*** N/A	10.000	-
Congressional Adds Subtotals	25.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602618A / *Ballistics Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	103.484	85.309	75.541	-	75.541	75.850	77.416	82.325	85.835	0.000	585.760
H80: *Survivability And Lethality Technology*	-	83.484	85.309	75.541	-	75.541	75.850	77.416	82.325	85.835	0.000	565.760
HB1: *SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)*	-	20.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	20.000

A. Mission Description and Budget Item Justification

This Program Element (PE) investigates and evaluates materials and technologies, and designs and develops methodologies and models required to enable enhanced lethality and survivability. Project H80 focuses on applied research of lightweight armors and protective structures for the Soldier and vehicles; kinetic energy active protection; crew and components protection from ballistic shock and mine-blast; insensitive propellants/munitions formulations; novel multi-function warhead concepts; affordable precision munitions design; techniques, methodologies, and models to analyze combat effectiveness and identify potential technology vulnerabilities; and technologies, methods, and tools for injury prediction of vehicle occupants during under-body blast events.

Work in this PE makes extensive use of high performance computing and experimental validation and builds on research transitioned from PE 0601102A (Defense Research Sciences)/Project H42 (Materials and Mechanics) and Project H43 (Ballistics); and utilizes emerging materials from PE 0602105A (Materials Technology) and applies it to specific Army platforms and the individual Soldier applications.

The work in this PE complements and is fully coordinated with efforts in PE 0602120A (Sensors and Electronic Survivability), PE 0602303A (Missile Technology), PE 0602601A (Combat Vehicle and Automotive Technology), PE 0602624A (Weapons and Munitions Technology), PE 0602705A (Electronics and Electronic Devices), PE 0602716A (Human Factors Engineering), PE 0602786A (Warfighter Technology), PE 0603125A (Combating Terrorism-Technology Development), PE 0603001A (Warfighter Advanced Technology), PE 0603004A (Weapons and Munitions Advanced Technology), PE 0603005A (Combat Vehicle Advanced Technology), PE 0603313A (Missile and Rocket Advanced Technology), and PE 0708045A (Manufacturing Technology).

The cited work is consistent with the S&T priorities of the Army Chief of Staff, Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

Work in this PE is performed by the Army Research Development and Engineering Command (RDECOM).

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army	Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602618A *I Ballistics Technology*

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	85.436	85.309	86.797	-	86.797
Current President's Budget	103.484	85.309	75.541	-	75.541
Total Adjustments	18.048	0.000	-11.256	-	-11.256
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	20.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.927	-			
• Adjustments to Budget Years	-	-	-11.256	-	-11.256
• FFRDC	-0.025	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: HB1: *SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)*		
Congressional Add: *Congressional Program Increase*	20.000	-
Congressional Add Subtotals for Project: HB1	20.000	-
Congressional Add Totals for all Projects	20.000	-

Change Summary Explanation

Reductions in investments in FY19 reflects the maturation of several efforts which were concluded and realignments to support Army priorities.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602618A / *Ballistics Technology*	Project (Number/Name) H80 / *Survivability And Lethality Technology*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H80: *Survivability And Lethality Technology*	-	83.484	85.309	75.541	-	75.541	75.850	77.416	82.325	85.835	0.000	565.760

A. Mission Description and Budget Item Justification

This Project investigates, designs and develops materials, methods and models that provide Soldier protection by enhancing survivability and lethality. Specific technology and research thrusts include: lightweight armors and protective structures; crew and component protection from ballistic shock and/or mine-blast; insensitive high energy propellants/munitions to increase lethality and reduce propellant/munitions vulnerability to attack; novel kinetic energy (KE) penetrator concepts to maintain/improve lethality; novel multi-function warhead concepts to enable defeat of a full-spectrum of targets (anti-armor, bunker, helicopter, troops); techniques, methodologies and models to analyze combat effectiveness and identify potential vulnerabilities in current and emerging technologies; and technologies, methods, and analysis tools for injury prediction of vehicle occupants during under-body blast events.

This Project supports efforts in the Army Science and Technology Ground, Lethality, Command, Control, Communications and Intelligence (C3I), and Soldier Portfolios.

The cited work is consistent with the Science and Technology (S&T) priorities of the Army Chief of Staff, the Assistant Secretary of Defense for Research and Engineering S&T priority focus areas, and the Army Modernization Strategy.

The Ground Portfolio technology investments are creating a layered vehicle protection suite including Active Protection (Hard-Kill and Soft-Kill) capabilities supported by robust advanced armor.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Underbody Blast & Occupant Protection	2.220	1.598	-
Description: This effort investigates and designs tools, techniques, and technologies for protection against mine/improvised explosive device (IED) blast threats, ballistic shock mitigation, and fuel/ammunition fires to enable survivability of current and future platforms. This research is coordinated with Program Element (PE) 0602601A (Armor Applied Research) and PE 0603005A (Combat Vehicle Survivability). ***FY 2018 Plans:*** Advance the development of protection mechanisms to defeat penetrator mines; continue development of blast protection hull designs for ground platforms. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort ends in FY18.			
Title: Low Cost Hyper-Accuracy Munition Technologies	3.758	3.779	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: This effort designs advanced components/subsystems to enable a broad spectrum of future affordable direct and indirect fire precision munitions. The focus is on a multidisciplinary approach to munition systems design by coupling physics-based models of interior ballistics, launch dynamics, flight mechanics, and high-gravitational force guidance, navigation, and control (GN&C) technologies. The goal is for smaller, cheaper and lighter munition components enabling low-collateral-damage precision munitions for future asymmetric operations in military operations on urban terrain (MOUT). ***FY 2018 Plans:*** Conduct end-to-end launch and guided flight demonstration of moving target intercept on laboratory range with low cost components in moderate size, weight, and power package; define critical technologies, scientific challenges, and engineering issues that inhibit precision weapons and future vehicle-mounted weapons against advanced threats. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Efforts ends in FY18.			
Title: Disruptive Energetics and Propulsion Technologies	8.307	8.377	8.084
Description: This effort investigates, evaluates, models, and informs the selection of propulsion and energetic materials and technologies to validate novel energetic materials concepts (such as nano-structural and insensitive) that exploit managed energy release required for improving the effectiveness and reducing the vulnerability of future gun/missile systems and warheads. This effort builds on disruptive energetic materials discovery efforts in PE 0601102A (Defense Research Sciences)/Project H43 (Ballistics) to synthesize new materials with energy content up to ten times that of Research Department Explosive (RDX). ***FY 2018 Plans:*** Characterize performance of materials produced for both propellant and energetic applications; predict reactive material response to insult using an experimentally-validated multiscale model; accurately model the effects of microstructure on the dynamic response of energetic material composites; predict the burning rates of nitrate ester-based formulations with disruptive energetics additives; and extend computational models to adequately predict the behavior of three-dimensional (3D) solid propellants. ***FY 2019 Plans:*** Will develop scale-up capability of multiple classes of disruptive energetic materials, testing and performance evaluation of disruptive energetic materials; develop computational methodology to model/predict behavior for energetic materials in explosives and propellants composites at extreme conditions; develop mechanisms for modeling the gas-phase chemistry associated with the combustion of solid propellants; develop technologies to extend the range and velocity of small, medium and large caliber projectiles. ***FY 2018 to FY 2019 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Reduced investment in computational models of three-dimensional (3D) solid propellants to support cutting edge material development.			
Title: Lethal and Scalable Effects Technologies ***Description:*** This effort identifies and models preferred options to reduce energy/mass required to defeat emerging armor threats and to provide multi-purpose capabilities for revolutionary future lethality. In addition, this effort investigates technology options for scaling warhead lethality to enhance urban Warfighting capabilities including control of collateral damage. ***FY 2018 Plans:*** Develop affordable, robust kinetic energy lethal capabilities for medium and large caliber cannons; explore next generation warhead concepts that can defeat multiple types of threat targets; continue developing game-changing concepts for cooperative, distributed, and/or modular lethality; and seek to explain non-lethal mechanisms. ***FY 2019 Plans:*** Will explore new materials and architectures to reduce the weapon mass required to launch and deliver lethal mechanisms; experimentally demonstrate the ability to modify high energy muzzle blast fields; explore warhead concepts that can simultaneously defeat multiple targets. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased investments to develop hybrid materials for lethal mechanisms.	5.670	5.724	6.482
Title: Survivability/Lethality Analyses ***Description:*** This effort devises state-of-the-art survivability/lethality/vulnerability methodologies to dynamically model the interaction of conventional ballistic threats against future weapon systems. ***FY 2018 Plans:*** Design, develop, and validate scientifically sound and user-friendly predictive methodologies for determining threat-target interaction outcomes for novel targets and threat mechanisms, to provide quantitative estimates for supporting formal evaluation of Army systems, design trade space examinations and milestone decisions; mature engineering-level complex systems methodologies that can run stand-alone or with humans in-the-loop; and provide system developers and decision makers with credible investigations of the complex relationships among new technologies, combat effectiveness, evolving threats, non-traditional military environments, and military systems. ***FY 2019 Plans:*** Will design and develop new analytical methodologies and models to assess the highest priority new foreign and American technologies with the highest likelihood of affecting the ballistic survivability of Soldiers and fielded and developmental Army system; conduct experiments to characterize high resolution, time dependent penetration and failure mechanisms in ballistic	8.273	7.473	6.572

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
events and will exploit for applied mechanism that can be used in future Army systems; continue to investigate energy-efficient penetrator and warhead concepts for direct-fire, distributed, and cooperative lethality scenarios; develop deeper understanding of the science associated with non-lethal incapacitation. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decreased investments in engineering-level complex systems methodologies to support increase of investments in underbody blast (UBB) effects on ground vehicles.			
Title: Multi-Threat Armor Formulations and Designs ***Description:*** This effort devises and matures multi-threat hybrid armor technologies incorporating both active and passive mechanisms for ground vehicle systems that are effective against future conventional weapons and evolving improvised threats. This research is coordinated with PE 0602601A (Armor Applied Research) and PE 0603005A (Combat Vehicle Survivability). ***FY 2018 Plans:*** Develop hybrid armor concepts that optimize multiple mechanisms to include EMA and ERA, as well as new novel designs, to provide multi-threat defeat; experimentally validate promising passive and reactive armor concepts based on modeling and simulation efforts; conduct experiments using emerging threats against existing mechanistic designs; further develop experimental and computational modeling capabilities to enable multi-threat, multi-hit armor mechanism design and validation; determine physical mechanisms that contribute to multi-material armor design by increasing imaging and velocimetry diagnostic capability (i.e., measuring velocity) and design of novel experiments. ***FY 2019 Plans:*** Will mature promising multi-threat armor designs utilizing hybrid electromagnetic armor (EMA)/energetic technologies; will verify results both computationally and experimentally. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased investments to develop threat ID approaches in real-time.	19.697	18.795	19.541
Title: Adaptive and Cooperative Protection Technologies ***Description:*** This effort pursues a holistic approach toward achieving significant weight reduction and defeat of future threats by utilizing real-time information, combined with threat knowledge, to provide ever-increasing protection. This approach includes integrating individual vehicle capabilities of armor, underbody blast protection, active protection systems (APS), and advanced soft kill methods into one solution to maximize survivability and minimize weight for combat and tactical vehicles. This research is coordinated with PE 0602601A (Armor Applied Research) and PE 0603005A (Combat Vehicle Survivability). ***FY 2018 Plans:***	2.795	6.393	12.183

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Assess current sensor/warner/tracker technologies that can warn of attack and identify threats of interest (such as RPGs and ATGMs); and explore multiple actuation technologies including mechanical actuation, energetic materials, and pulsed power in conjunction with selected counter measures. ***FY 2019 Plans:*** Will conduct computational and experimental research to mature/optimize promising adaptive armor designs. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased investments to explore approaches that provide a more offensive approach to protection.			
Title: Ballistic and Blast Protection for Dismounted Soldiers ***Description:*** This effort develops unique physics-based models to understand the deflection and stress wave interactions with the human during the complex target interactions between threats and personal protective equipment (PPE). Use this knowledge framework to develop low technology readiness level (TRL) Personal Protective Equipment (PPE) concepts that are informed by the human effects during impact and blast events. ***FY 2018 Plans:*** Perform computational/experimental analysis of disruption mechanisms against legacy bullet technologies; simulate helmet/pad/head interaction for various loading scenarios; investigate soft tissue and hard tissue injury mechanisms; will explore new concepts in limb protection from blast events. ***FY 2019 Plans:*** Will investigate the physics of failure for emerging threats utilizing high definition experiments to identify phenomena and calibrate the ballistic models; will finalize injury models for soft and hard tissues for ballistic impact. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decreased investment in materials research for Soldier protection in order to support the acceleration of other materials research.	6.561	6.700	6.274
Title: Soldier Lethality Technologies ***Description:*** This effort focuses on development of advanced lethal mechanisms, improved accuracy approaches, and leverages state-of-the-art materials to enable a single small arms cartridge for defeat of hard and soft targets and enable the defeat of combatants in defilade out to 2 km.	0.797	-	-
Title: Warrior Injury Assessment Manikin (WIAMan) ***Description:*** This work develops an improved demonstrator blast test manikin, data acquisition system, and injury prediction methods and tools that incorporate new medical research and which provides an improved capability to measure and predict skeletal injuries for vehicle occupants during under-body blast events. Transfer of responsibilities and funding from PE 0602787A	8.808	6.446	4.009

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
(Medical Technology)/Project 869 (Warfighter Health Protection & Performance Standards, Army Medical Research and Materiel Command (MRMC) to ARL effective Fiscal Year (FY) 2015. This effort is coordinated with PE 0602601A (Armor Applied Research) and PE 0603005A (Combat Vehicle Survivability). ***FY 2018 Plans:*** Mature and assess the first data acquisition system components; conduct design iterations to mature the WIAMan efforts from the Technology Demonstrator to a fully-integrated Generation-1 Prototype; begin to assess biofidelity, strength of design, and technology readiness level of the Generation-1 Prototype; commence injury biomechanics testing; and update and validate the finite element model. ***FY 2019 Plans:*** Will complete injury biomechanics testing and injury assessment reference curves; will validate finite element model for Generation-1 ATD for risk assessment capabilities; will complete injury analysis tool development. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Investment reduced as WIAMan research matured.			
Title: Vulnerability Assessment of Technologies ***Description:*** This effort reviews high-priority developmental technologies in the context of current and emerging threats, identifies tradeoffs, and develops risk reduction strategies to promote the development of technologies that are "threat ready?. State-of-the-art vulnerability assessment methodology and tools are applied across a broad spectrum of threats in order to investigate potential vulnerabilities and identify mitigation options early in the materiel development cycle. This work complements and is coordinated with PE 0603125A (Combating Terrorism-Technology Development)/Project DF5 (Agile Integration & Demonstration). ***FY 2018 Plans:*** Conduct technology vulnerability assessments of developmental technologies that have high likelihood for maturation into future Army systems. FY18 assessments investigate potential vulnerabilities in emerging laboratory products, including technologies to enable the following future capabilities: advanced Position, Navigation and Timing for global positioning system (GPS)-challenged environments; defeat of adversary weapons systems guidance through threat-agnostic countermeasures; combat vehicle active protection systems; sensing and flight control in degraded visual environments; land-based anti-ship missile for engagement of heavily defended maritime surface combatants; and anti-jam solutions for precision guided missiles. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort concludes in FY18 due to a change in the priority of the effort.	8.706	8.840	-
Title: Active Protection Modeling and Technologies	3.217	5.407	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: This effort supports the development of Active Protection System (APS) technologies and common architecture to reduce vehicle weight while significantly increasing protection against current and emerging advanced threats by reducing reliance on armor through other means such as sensing, warning, and active countermeasures. The APS common architecture will provide adaptable APS solutions that can be integrated across Army vehicle platforms as required. This research includes the development of new modeling and simulation capabilities along with supporting experimental and theoretical approaches to enable active protective systems. This effort includes integrated information (e.g., battlefield geography, threat launch detection and tracking) and intelligence to inform protection optimization, requiring collaboration across multiple Army organizations. This effort complements and is coordinated with PE 0602601A (Combat Vehicle and Automotive Technology)/Project C05 (Armor Applied Research), PE 0603004A (Weapons and Munitions Advanced Technology)/Project 232 (Advanced Lethality & Survivability Demo), PE 0603005A (Combat Vehicle Survivability and Automotive Advanced Technology)/Project 221 (Combat Vehicle Survivability), PE 0603270A (Electronic Warfare Technology)/Project K16 (Non-Commo ECM Technology Demo), and PE 0603313A (Missile and Rocket Advanced Technology) / Project 263 (Future Missile Technology Integration). ***FY 2018 Plans:*** Compare simulation and experimental results of softkill physical demonstrations; computationally investigate performance of layered hardkill concepts with adaptive protection mechanisms; and simulate counter-counter measures against specific hard-kill/ soft kill solutions. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort ends in FY18.			
Title: Swarming Weapons Technologies ***Description:*** This effort develops concepts for simultaneous and assured delivery of multiple lethal payloads at extended ranges to challenging (e.g., moving) targets in constrained and contested environments (such as highly dynamic and mixed personnel environments, and Global Positioning System (GPS) denied environments) through the use of highly collaborative teaming and distributed intelligence, perception, estimation, and control theories and technologies. ***FY 2018 Plans:*** Produce realistic models for targets in complex environments; determine reduced-bandwidth communications strategy between vehicles; implement these navigation technologies in simple experiments (e.g., ground or air robots). ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort ends in FY18.	4.675	4.772	-
Title: Multi-scale Materials Modeling for Force Protection	-	1.005	0.884

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: This effort develops computational tools for the design of terminal ballistic concepts and material-specific properties to enable novel penetrator-target interactions. Multi-scale materials models developed in previous 6.1 (Basic Research) programs are transitioned to simulation framework suitable for impact and penetration modeling. This approach includes fusing materials and mechanisms to maximize survivability and minimize weight for combat and tactical vehicles. ***FY 2018 Plans:*** Develop models to enable ability to perform concurrent armor concept and armor-material design. ***FY 2019 Plans:*** Will perform limited V&V assessments of computational capability; transition ALEGRA and ALE3D models to Sandia and Livermore National Labs; develop 2d generation models. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduced investments as models evolve and less research is required.			
Title: Emerging Overmatch Technologies ***Description:*** This effort supports the development and demonstration of lethality and protection concepts that re-establish overmatch for the next generation of manned and unmanned combat platforms. It will tightly couple scientific research within a campaign of learning to form technology concepts for battlefield domination. ***FY 2019 Plans:*** Will explore advanced protection and lethal mechanisms to enable the next generation combat vehicle and small autonomous systems; will seek to model operational effects based on laboratory/range experiments. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Investment to identify emerging threats and ways to achieve overmatch.	-	-	2.245
Title: Precision and Cooperative Weapons in Denied Environments ***Description:*** The goal of this research is to deliver weapon payloads in more extreme environments (e.g., speed, time, size, survivability, number of agents) against complex, evolving threats (e.g., evading, hiding, counter-measured). Research focuses on understanding and enabling weapons technologies in the areas of vehicle design, control mechanisms, algorithms, embedded processing, and onboard sensing for multi-agent systems with limited, potentially-hostile guidance feedback information. ***FY 2019 Plans:*** Will conduct free-flight computational and experimental investigation of enhanced open-loop control maneuver technologies in subsonic regime; study structural response of control mechanism technologies for extremely high-G (>60kGs) launch survivability; investigate gun-launched morphing airframe technologies using computational and experimental methods; validate anchored and	-	-	9.267

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602618A / *Ballistics Technology*	**Project (Number/Name)** H80 / *Survivability And Lethality Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
unanchored localization technologies for navigation in denied environments on low-speed vehicle in flight experiments and on high-speed vehicle in high-fidelity simulation. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Investment to support Soldier Lethality senior leader priorities for weapons research.			
Accomplishments/Planned Programs Subtotals	83.484	85.309	75.541

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602618A / *Ballistics Technology*	Project (Number/Name) HB1 / *SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
HB1: *SURVIVABILITY AND LETHALITY TECHNOLOGIES (CA)*	-	20.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	20.000

Note

Congressional increase for Program increase

A. Mission Description and Budget Item Justification

These are Congressional Interest Items

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Congressional Program Increase	20.000	-
FY 2017 Accomplishments: N/A		
Congressional Adds Subtotals	20.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602622A *I Chemical, Smoke and Equipment Defeating Tech*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	3.772	4.004	5.032	-	5.032	5.612	4.195	4.281	4.367	0.000	31.263
552: *Smoke/Novel Effect Mun*	-	3.772	4.004	5.032	-	5.032	5.612	4.195	4.281	4.367	0.000	31.263

A. Mission Description and Budget Item Justification

This Program Element (PE) investigates and evaluates obscurant technologies to increase personnel and platform survivability and develop and validate forensic analysis methods for military and homemade explosive devices, including their precursors and residue. Project 552 pursues research in materials science as well as dissemination methodologies, mechanisms, technologies, and techniques to enable forensic analysis of explosive signatures.

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

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

This work is performed by the Army Research, Development, and Engineering Command (RDECOM)

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	3.923	4.004	5.032	-	5.032
Current President's Budget	3.772	4.004	5.032	-	5.032
Total Adjustments	-0.151	0.000	0.000	-	0.000
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.149	-			
• FFRDC	-0.002	-	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602622A / *Chemical, Smoke and Equipment Defeating Tech*	Project (Number/Name) 552 / *Smoke/Novel Effect Mun*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
552: *Smoke/Novel Effect Mun*	-	3.772	4.004	5.032	-	5.032	5.612	4.195	4.281	4.367	0.000	31.263

A. Mission Description and Budget Item Justification

This Project investigates and evaluates obscurant technologies that degrade threat force surveillance sensors and defeat the enemy's target acquisition devices, missile guidance, and directed energy weapons. This Project focuses on advanced infra-red (IR) and multi-spectral obscurant materials that provide effective, affordable, and efficient screening of deployed forces, while being safe and environmentally acceptable. Additionally, it researches and investigates forensic analysis technology in explosives and explosives-related chemical signatures, and develops and validates field sampling and forensics methods for use in a forward-deployed laboratory.

This Project sustains Army science and technology efforts supporting the Ground Maneuver Portfolio.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Advanced Obscurants	1.468	1.518	1.563
Description: This effort investigates new materials and compounds to enable safe, effective screening of personnel and equipment. ***FY 2018 Plans:*** Measure screening performance of top candidate bispectral materials. Design and build a chamber to measure microwave obscurant performance. ***FY 2019 Plans:*** Will continue to mature and characterize advanced bispectral, will advanced microwave and spectrally selective obscurants. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased funding needed to achieve Smoke as a Soft kill measure in APS			
Title: Obscurant Enabling Technology	1.000	1.002	2.000
Description: This effort investigates distribution technologies for various obscurants. This effort will support Modular Active Protection System (MAPS) in 0602601/C05 and 0603005/221.			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602622A / *Chemical, Smoke and Equipment Defeating Tech*	**Project (Number/Name)** 552 / *Smoke/Novel Effect Mun*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2018 Plans: Evaluate performance of pneumatic dissemination against the performance of other distribution technologies. Continue to conduct vulnerability studies of various technologies to obscurant/target defeat effects. ***FY 2019 Plans:*** Will document vulnerability studies analyses. Will develop new vehicle protection concepts based on vulnerability studies of anti-tank guided missiles. Will continue to conduct vulnerability studies of various technologies to obscurant/target defeat effects. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Maturing program costs for experimentation hardware			
Title: Forensic Analysis of Explosives ***Description:*** This effort investigates forensics analytical methods for military explosives, homemade explosives (HME), HME precursors, and residue analysis for attribution. ***FY 2018 Plans:*** Investigate integrated photonics chips as a proof of concept device for the detection of explosives, drugs, and other molecules of interest for forensic analysis and wearable detectors; investigate a proof of concept device for the sensing explosives and precursor chemicals based on impedance using novel dielectric materials. ***FY 2019 Plans:*** Will investigate Photonic Integrated Circuits (PIC) for chemical sensing of explosives, narcotics, and other chemicals of interest for forensic analysis and personnel borne detectors. Will investigate metal organic framework polymer composites to enhance selectivity in explosives detection. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Slight reduction to support obscurant enabling technology	1.304	1.484	1.469
Accomplishments/Planned Programs Subtotals	3.772	4.004	5.032

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602622A / *Chemical, Smoke and Equipment Defeating Tech*	**Project (Number/Name)** 552 / *Smoke/Novel Effect Mun*

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602623A *I Joint Service Small Arms Program (JSSAP)*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	5.331	5.615	12.394	-	12.394	5.031	5.132	5.919	6.037	0.000	45.459
H21: *Jt Svc Sa Prog (JSSAP)*	-	5.331	5.615	12.394	-	12.394	5.031	5.132	5.919	6.037	0.000	45.459

A. Mission Description and Budget Item Justification

This Program Element (PE) investigates individual and crew-served weapon designs and technologies that enhance the fighting capabilities and survivability of the dismounted Warfighter in support of all of the Services. All work is led by the Joint Service Small Arms Program (JSSAP) and is based upon the Joint Service Small Arms Master Plan (JSSAMP) and the Joint Capabilities Integration Development System's Small Arms Analyses.

Work in this PE is related to, and fully coordinated with, efforts in PE 0601102A (Defense Research Sciences), PE 0602624A (Weapons and Munitions Technology), PE 0603607A (Joint Service Small Arms Program), and PE 0602618A (Ballistic Technology).

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

The work in this PE is performed by the Army Research, Development and Engineering Command (RDECOM).

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	5.545	5.615	5.576	-	5.576
Current President's Budget	5.331	5.615	12.394	-	12.394
Total Adjustments	-0.214	0.000	6.818	-	6.818
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.211	-			
• Adjustments to Budget Years	-	-	6.818	-	6.818
• FFRDC	-0.003	-	-	-	-

Change Summary Explanation

Funding increased in this PE to address higher priority Army Modernization efforts in the area of Soldier Lethality.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602623A / *Joint Service Small Arms Program (JSSAP)*	Project (Number/Name) H21 / *Jt Svc Sa Prog (JSSAP)*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H21: *Jt Svc Sa Prog (JSSAP)*	-	5.331	5.615	12.394	-	12.394	5.031	5.132	5.919	6.037	0.000	45.459

A. Mission Description and Budget Item Justification

This Project investigates individual and crew-served weapon component design and technologies that enable increased lethality for survivability of the dismounted Warfighter in all the Services. All efforts are based upon the Joint Service Small Arms Master Plan (JSSAMP) and the Joint Capabilities Integration Development System's Small Arms Analyses.

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

Work in this Project is related to, and fully coordinated with, efforts in Program Element (PE) 0602624A (Weapons and Munitions Technology) and PE 0603607A (Joint Service Small Arms Program) and PE 0602786A (Warfighter Technology).

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Weapon System and Enablers	1.788	1.881	1.868
Description: This effort investigates and evaluates small arms weapon systems and enabling technologies to include: weapon size, weight and power consumption, barrel properties, recoil force, balance, and suitability. This effort also investigates scalable effects weapons in order to increase warfighter capability by providing one cartridge/weapon system delivering variable effects from non-lethal to lethal at greater ranges than currently available.			
FY 2018 Plans: Design and develop active stabilization technologies to increase hit probabilities and advance next generation fire control technologies; investigate high pressure weapon operation cycling for increase ammunition terminal performance and increase speed to target engagements; mature precision munitions components to increase probability of incapacitation against near and far term enemy threats; develop new techniques for evaluating and improving the reliability of weapon systems with the end goal of increasing the Mean Rounds Between Failure (MRBF) and Mean Rounds Between Stoppages (MRBS); and investigate technologies to increase weapon reliability/durability through use of advance coatings which reduce or eliminate the need for conventional lubricants in weapon action components; design and develop a small arms barrel characterization tool to determine optimal weapon thermal loading, heat input, bore stresses, and chemical, thermal, mechanical erosion.			
FY 2019 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602623A / *Joint Service Small Arms Program (JSSAP)*	**Project (Number/Name)** H21 / *Jt Svc Sa Prog (JSSAP)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Will design and develop barrel and suppressor technologies to dissipate heat, and withstand higher chamber pressures as well as muzzle velocities. This design will yield increased small arms weapon performance. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decrease due to culmination of applied research efforts for advanced lubricant technologies.			
Title: Small Arms Ammunition Research ***Description:*** This effort addresses the design and evaluation of ammunition with reduced weight, signature, fouling and contaminants as well as improved terminal performance and improved performance against soft and hard targets. ***FY 2018 Plans:*** Design and develop ammunition technologies to support precision ammunition requirements for extended range, accuracy and terminal effects required to perforate toughest targets and implement highly efficient aerodynamics. These technologies support the development of next generation small arms ammunition. ***FY 2019 Plans:*** Will design and develop component technologies for a family of small arms ammunition in support of the Next Generation Squad Weapon that will result in increased probability of hit and effects on targets. Types of ammunition technologies to mature will include: enhanced performance round, advanced penetrating projectile, tracer round, reduced range training round ammunition (RRTA) and a RRTA tracer projectile. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding increased to allow higher priority Army Modernization efforts on the area of Soldier Lethality.	2.929	3.079	10.226
Title: Small Arms Technology Applied Research ***Description:*** This effort supports the requirements analysis and the long-term investigation and maturation of technologies to fulfill the Department of Defense small arms capability requirements. The Joint Service Small Arms Program continuously utilizes studies and evaluations to determine the feasibility of novel material concepts; investigate all potential interfaces between the Soldier, training, weapon, optics, and the ammunition; and explore and evaluate interior and exterior ballistic component technologies to enhance weapon performance. ***FY 2018 Plans:*** Investigate and mature a high pressure operating system capability to defeat current and future threats to the dismounted warfighter; investigate active stabilization technologies integrated with advance next generation fire control technologies to increase hit probabilities, increase kinetic speed to target and decrease engagement time; develop scalable precision munition technologies to a Technical Readiness Level (TRL) 4 to increase Warfighter capability in anti-materiel, anti-personnel and other	0.614	0.655	0.300

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602623A / *Joint Service Small Arms Program (JSSAP)*	**Project (Number/Name)** H21 / *Jt Svc Sa Prog (JSSAP)*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
specialized missions; develop to a TRL5 a Reduced Range Training Ammunition (RRTA) for reduced Surface Danger Zones (SDZ) ranges with a trajectory match to current combat ammunition; develop a system and method, both accurate and repeatable, to measure blowback produced by small caliber suppressors. ***FY 2019 Plans:*** Will incorporate small arms ammunition weapon technologies research into the Small Arms Ammunition Research project; will continue to investigate small arms technologies capable to defeat current and future threats to the dismounted warfighter as well as able to increase hit probabilities, kinetic speed to target, and decreased engagement time. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding decreased to allow higher priority Army Modernization efforts on the area of Soldier Lethality.			
Accomplishments/Planned Programs Subtotals	5.331	5.615	12.394

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602624A / *Weapons and Munitions Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	118.068	41.455	40.444	-	40.444	46.783	43.044	62.028	63.269	0.000	415.091
H18: *Weapons & Munitions Technologies*	-	20.936	21.455	18.243	-	18.243	20.910	14.661	16.972	17.312	0.000	130.489
H19: *Asymmetric & Counter Measure Technologies*	-	14.350	5.353	0.000	-	0.000	0.000	0.000	11.769	12.005	0.000	43.477
H1A: *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE*	-	66.500	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	66.500
H28: *Warheads/ Energetics Technologies*	-	16.282	14.647	22.201	-	22.201	25.873	28.383	33.287	33.952	0.000	174.625

A. Mission Description and Budget Item Justification

This Program Element (PE) investigates, designs and evaluates enabling technologies to develop lethal weapons and munitions with increased performance and the potential for lower weight, reduced size, and improved affordability. Project H18 focuses on weapons and munitions development. Project H19 researches technologies to maintain and enhance weapons lethality. Project H28 evaluates munition components such as fuzes, power, warheads with tailorable effects, and munition compliant energetic materials.

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

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

The work in this PE is performed by the Army Research, Development and Engineering Command (RDECOM).

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army	Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602624A *I Weapons and Munitions Technology*

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	53.581	41.455	48.825	-	48.825
Current President's Budget	118.068	41.455	40.444	-	40.444
Total Adjustments	64.487	0.000	-8.381	-	-8.381
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	66.500	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.988	-			
• Adjustments to Budget Years	-	-	-8.381	-	-8.381
• FFRDC	-0.025	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: H1A: *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE*		
Congressional Add: *Program Increase*	18.000	-
Congressional Add: *High-speed vehicle mounted fire detection technology*	5.000	-
Congressional Add: *Railgun weapon technology*	20.000	-
Congressional Add: *Medium caliber lightweight composite barrel technology*	5.000	-
Congressional Add: *Guided tank fired round development for high mobility targets*	8.500	-
Congressional Add: *Armament systems concepts*	5.000	-
Congressional Add: *hybrid projectile technology*	5.000	-
Congressional Add Subtotals for Project: H1A	66.500	-
Congressional Add Totals for all Projects	66.500	-

Change Summary Explanation

Congressional increase in H1A Weapons & Munitions Tech Program Initiative; funding decreased in this PE to address higher priority Army Modernization efforts in the area of Long Range Precision Fires.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602624A / *Weapons and Munitions Technology*	Project (Number/Name) H18 / *Weapons & Munitions Technologies*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H18: *Weapons & Munitions Technologies*	-	20.936	21.455	18.243	-	18.243	20.910	14.661	16.972	17.312	0.000	130.489

A. Mission Description and Budget Item Justification

This Project designs, investigates, and evaluates component technologies to enable affordable precision munitions as well as provide increased lethality and performance with reduced logistics and advanced direct/indirect fire capabilities for Soldier, ground vehicle and aviation platforms.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Novel Propulsion Technology for the Future	3.213	3.429	2.921
Description: This effort explores propellant technologies such as powder coextrusion and grain coatings, while retaining insensitive properties, for employment in gun launch environments as well as directional thrusters including those that deliver a broad spectrum of effects. It also conducts experiments with these propellants to increase the range of artillery and mortar rocket assisted projectiles.			
FY 2018 Plans: Optimize formulation and design electrode configurations for electrically controlled energetic materials (ECEM) which could enable extended range and improve precision and temperature compensation; design and develop igniter materials and characterize interaction between coated propellant grains and ignition system in development of a temperature invariant propulsion system; conduct experiments to transform feed stock propellant formulations into spheroidal geometries using advanced processing techniques; mature the die design and formulation developed organically for co-extrusion processing; mature novel propellant formulations and validate models and experiments while investigating increased propellant masses for use in co-developed foam celluloid combustible case; continue to investigate, research, and mature new rocket motor formulations for use in emerging rocket assisted projectiles to determine potential range increases.			
FY 2019 Plans: Will investigate alternative processing methods amenable to achieving high-energy formulations in spheroidal and/or pancake geometries in conjunction with development of high-energy propellant formulations; will investigate processing methods, material synthesis and formulation to support development of encapsulated propellant, which could result in improved stability/sensitivity			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H18 / *Weapons & Munitions Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
and combustion profiles without sacrificing combustion performance; will validate the optimized electrode configuration and formulation for electrically controlled energetic materials (ECEM). ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decrease is due to propellant design formulations completed and available for processing and synthesis validation.			
Title: Advanced Weapons Technology ***Description:*** This effort investigates innovative weapon technologies such as recoil energy mitigation, affordable precision, extended range/guided technologies, and advanced propellant for future medium caliber direct fire systems that could provide similar or greater lethality than current systems. ***FY 2018 Plans:*** Investigate novel weapon technologies that will allow for heat check techniques of cracks in explosives; conduct experiments to develop cold spray deposition processes for erosion resistant metal coatings. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort completed in FY18.	1.420	0.824	-
Title: Affordable Precision Technologies ***Description:*** This effort investigates technologies that provide affordable precision capabilities for projectiles fired into Global Positioning System (GPS) denied environments. ***FY 2018 Plans:*** Characterize thoroughly the image navigation component and subsystem technologies across the operational conditions in order to ensure a robust Technology Readiness Level 5 (TRL-5) is achieved for all of the enabling subsystems; a new low Size, Weight, and Power (SWaP) Tactical Grade Gun Hardened Inertial Measurement Unit (IMU) will be demonstrated to a TRL-5. ***FY 2019 Plans:*** Will investigate the optimal architecture for an Automatic Target Recognition (ATR) capable Precision Guided Munition (PGM); will include initial system trade studies, modeling of various seeker types on candidate indirect fire platform systems and experimental assessments of high risk critical components. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decrease is due to project completing the phase of component technologies characterization.	2.809	3.015	2.652
Title: Extended Range Indirect Fire Weapon Technology	2.809	2.783	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H18 / *Weapons & Munitions Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: This effort initially investigates and determines the viability of candidate extended range indirect fire weapon technologies that facilitate light weight armaments with launch velocities resulting in ranges of 70km and beyond with emerging ammunition. Technologies will be applied at the system and sub-system level to address technology gaps. ***FY 2018 Plans:*** Continue to mature extended range indirect fire component technologies and conduct integrated experiments to validate technologies for use with the M109A7 howitzer system to determine system impacts of the extended range capability as well as investigate the application of these technologies to other indirect fire systems such as the M777A2 and M119A3. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Applied Research phase completed.			
Title: Force Protection Technologies ***Description:*** This effort accelerates the development of disruptive technologies that enable transformational protection capabilities for vital assets, forces and civilian populations, increasing safety, decreasing collateral damage and minimizing fratricide.	0.472	-	-
Title: Long Range Gun Technology Development ***Description:*** This effort investigates and develops candidate extended range artillery weapon system and projectile technologies that increase the range up to 2x with increased precision. Resulting component technologies will be evaluated and matured in the fully coordinated effort of the same name in PE/Project 0603004A/232. ***FY 2018 Plans:*** This effort is conducted in concert with the Extended Range Indirect Fire Weapon Technology effort to determine weight reduction of common 155mm armament concepts integrated with advanced micro-common fire control concepts to achieve extended range for demonstration mentioned in PE/Project 0603004A/232; validates post launch propulsion methods for next generation extended range munitions and determine range extension gains that could be achieved by new designs of post launch projectile lifting surfaces. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort completed the Applied Research phase.	2.317	1.500	-
Title: Fuze and Power Technologies for Munitions	1.896	2.080	1.054

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H18 / *Weapons & Munitions Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: This effort investigates and designs innovative fuze and power technologies for enhanced environment and target sensing/classification, warhead initiation schemes and advanced fuze setting to provide enhanced lethality combined effects on targets and advanced initiation schemes for the next generation munitions. ***FY 2018 Plans:*** Continue to mature advanced sensor components and devices; mature advanced initiation systems applicable to insensitive munitions; mature and validate advanced power technologies for medium and large caliber munitions; and mature airburst fuzing technologies for reduced range error in medium caliber fuzing. These technologies continue to support the Joint Munitions Program TCG ? 5 and TCG-10 and the JFTP. ***FY 2019 Plans:*** Will advance the capability of state of the art in fuze proximity sensors to track targets in order to improve burst point accuracy and countermeasure robustness; will maximize usage of all real time battlefield targeting data and integrate with fuze setters, fuze sensors, power sources, component protective technologies and unique fuze ignition schemes to design and develop extremely reliable and versatile fuzes; will investigate these new fuze designs to support hypersonics, autonomous fuzing for varied targets as well as Counter-Unmanned Aerial Systems. These technologies will continue to leverage the OSD Joint Munitions Program TCG - 5 and TCG-10 and the OSD Joint Fuze Technology Program. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decrease is due to maturation of sensor components and airburst technologies.			
Title: Cluster Munitions Replacement Acceleration ***Description:*** This effort will design and develop the critical components that will aid in the maturation of a materiel solution designed to replace 155mm dual purpose improved conventional munition (DPICM) artillery. The components will include the design, development and component testing of fuzing, warhead and stabilization technologies. ***FY 2018 Plans:*** Investigate and mature fuze initiation train design; research and develop novel designs of arming, warhead and stabilization architectures; conduct lab experiments for critical components to validate reliability and functionality claims; fund research looking at the effectiveness of materiel solutions for various concepts. ***FY 2019 Plans:***	6.000	7.000	1.050

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H18 / *Weapons & Munitions Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
This effort will begin to validate the tactical designs for all concepts, and will investigate incorporating additional features into the design of critical components; will improve insensitive munitions (IM) performance as well as investigate and determine what other technologies could be incorporated into the materiel solutions as a potential improvements. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decrease is due to cluster munition replacement technology transitioning from Applied Research to Advanced Demonstration in FY19.			
Title: Programmable Intelligent Collaborative Engagement Munition ***Description:*** This effort develops, matures and integrates a gun hardened suite of components (software, sensors, navigation and communications) that enable the application of distributed, cooperative and collaborative tactics for munitions. ***FY 2018 Plans:*** Develop collaborative algorithms, which will include a set of tools like target assignment based on probability of kill scoring, target assignment with must hit priority where total probability of kill priority is applied after must hit criteria are achieved, and 3D pattern goals with arrival time objectives. ***FY 2019 Plans:*** Will design and develop hardware and mature algorithms and concepts validated in the prior year to a breadboard state; will utilize hardware and software in the loop testbed to validate collaboration across multiple munitions in flight. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase is due to the efforts needed for the building of hardware and generation of algorithms to demonstrate munition collaboration capability.	-	0.824	1.500
Title: Advanced Rotorcraft Armaments Protection System ***Description:*** The Advanced Rotorcraft Armament and Protection System (ARAPS) effort designs and develops Future Vertical Lift (FVL) technologies for lightweight armament systems and multi-role munitions with enhanced lethality at extended ranges. The effort investigates and determines the feasibility of a holistic fire control system that integrates all aspects of offensive and defensive capabilities for advanced protection and enhanced survivability. ***FY 2019 Plans:*** Will investigate integrated armament and advanced protection designs for Future Vertical Lift (FVL) offensive and defensive applications; will design critical component technologies in order to develop advanced lethality and survivability capabilities in	-	-	4.566

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H18 / *Weapons & Munitions Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
fire control, weapon systems, munitions and countermeasures; will investigate system architecture solutions for an integrated armament and advanced protection system. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** First year of effort.			
Title: Radio Frequency Guided Munition ***Description:*** This effort investigates technologies that provide a Radio Frequency (RF) seeking capability for gun-launched projectiles to enable engagement of RF emitting sources and similar targets of interest. ***FY 2019 Plans:*** Will investigate RF seeker component technologies with a focus on projectile payload performance, size, weight, power, and gun launch survivability; will perform systems engineering and detailed performance analyses to determine the trade space when integrating these RF seeker technologies in gun-launched environments. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** First year of effort.	-	-	1.500
Title: ARCHER ***Description:*** This effort designs and develops advanced fire control algorithms and a multirole warhead guided projectile for area defense against medium (Groups 2 and 3) sized unmanned aerial systems (UAS) and aerial rotary wing platforms, point defense against rocket propelled grenades (RPGs), anti-tank guided missiles (ATGMs), and rocket, artillery, and mortars threats as well as precision fires against dismounts in defilade. ***FY 2019 Plans:*** Will investigate and mature command guided, medium caliber projectile designs on a tactical turret platform; will research and develop novel warhead and projectile stabilization architectures; will conduct lab experiments to mature designs of projectile critical components; will validate reliability, functionality and performance of various projectile component technologies; will research the target defeat effectiveness of material solutions for various concepts and develop algorithms based on armament system requirements. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** First year of effort.	-	-	3.000
Accomplishments/Planned Programs Subtotals	20.936	21.455	18.243

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H18 / *Weapons & Munitions Technologies*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602624A / *Weapons and Munitions Technology*	Project (Number/Name) H19 / *Asymmetric & Counter Measure Technologies*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H19: *Asymmetric & Counter Measure Technologies*	-	14.350	5.353	0.000	-	0.000	0.000	0.000	11.769	12.005	0.000	43.477

A. Mission Description and Budget Item Justification

This Project designs and develops technologies to support asymmetric countermeasures such as efforts to maintain the lethality and overmatch of United States (US) weapons against current and future threat systems. Work in this Project is related to, and fully coordinated with, efforts in Projects H18 and H28 (also in Program Element (PE) 0602624A), PE 0602618A (Ballistics Technology), and projects 232 and L94 in PE 0603004A (Weapons and Munitions Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Novel Battlefield Effectors ***Description:*** This effort investigates unique weapon and munitions enabling technologies to achieve tunable effects on targets and that are capable of providing a full range of effects from non-lethal to highly lethal via a single weapon or munition.	2.268	-	-
Title: Counter-Countermeasure (CCM) Technologies for Weapons and Munitions ***Description:*** This effort investigates guidance signal reduction, inertial measurement unit, and antenna design technologies to enable continued effectiveness of US weapon systems against enemy countermeasures including Active Protection Systems (APS), Global Positioning System (GPS) jamming, and active seeker jamming. ***FY 2018 Plans:*** Mature technologies providing active counter-countermeasures against radio frequency (RF) threats; develop advanced materials for passive protection and structural enhancements; conduct designs of experiments to isolate key variables for design enhancements; integrate technologies for performance characterization against simulated threats. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decrease due to realignment of funding in support of the Accelerated Extended Range Artillery Munition Suite effort (PE 0603004A/Project 232)	1.407	1.309	-
Title: Enhanced Fire Control for Indirect Fires	1.923	2.044	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H19 / *Asymmetric & Counter Measure Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: This effort evaluates the applicability and integration of state-of-the-art acquisition and engagement technologies for data and image processing, weapon orientation sensors and methodologies to enhance fire control capability, and therefore weapon effectiveness, at various ranges and under battlefield conditions. Investigates components and architectures that will reduce size, weight, power and cost (SWaP-C), and increase commonality and operation across direct and indirect fire control systems. ***FY 2018 Plans:*** Mature extended range tracking, in flight communications and miniaturization of components for use in Global Positioning System (GPS)-denied environments as well as navigation and pointing technologies/compensation components; validate improved conventional munition accuracy and develop common graphical user interfaces for fire control systems to allow for cross platform use and enable multi-role functionality. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort completed in FY18.			
Title: High Powered Radio Frequency ***Description:*** This effort in High Power RF technology focuses on addressing the SWaP-C of High Power RF systems and their components so as to allow tactically useful systems.	1.925	-	-
Title: Terrain Shaping Munition Technologies ***Description:*** This effort develops an improved munition capability, remote delivery, and man-in-the-loop control technologies that will allow the warfighter to maintain dominance in the battlefield by denying adversaries access to an area of operations. ***FY 2018 Plans:*** Validate munition architectures across delivery ranges against safety, reliability, and performance requirements; conduct experiments of large area coverage anti-personnel effects; investigate and confirm design with use of new dielectric and de-poling materials and conduct experimentations to validate different configurations and field layouts capable of handling high voltages in very compact form factor; collect validation data for effects study to identify output requirement and design tuning; conduct study on delivery mechanisms; and provide data for improving performances. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort completed in FY18.	1.923	2.000	-
Title: Small Arms Fire Control	4.039	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H19 / *Asymmetric & Counter Measure Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: This effort focuses on providing the soldier a set of small arms capabilities to increase the accuracy at extended ranges, probability of hit, improve time of engagement, and enhance situational awareness. By achieving these objectives, the soldier will be able to improve their operational effectiveness in reduced time.			
Title: Indirect Fire Aiming Techniques ***Description:*** This effort supports future integrated aiming technologies for indirect fires with enhanced capabilities and a simplified user interface while reducing size, weight and power.	0.865	-	-
Accomplishments/Planned Programs Subtotals	14.350	5.353	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040 / 2					R-1 Program Element (Number/Name) PE 0602624A / *Weapons and Munitions Technology*				Project (Number/Name) H1A / *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE*			
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
H1A: *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE*	-	66.500	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	66.500

Note

Congressional increases for Program increase ($18M); High-speed vehicle mounted fire detection technology ($5M); Railgun weapon technology ($20M); Medium caliber lightweight composite barrel technology ($5M); Guided tank fired round development for high mobility targets ($8.5M); Armament systems concepts ($5M); Hybrid projectile technology ($5M)

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Weapons and Munitions Technology applied research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Program Increase	18.000	-
FY 2017 Accomplishments: N/A		
Congressional Add: High-speed vehicle mounted fire detection technology	5.000	-
FY 2017 Accomplishments: N/A		
Congressional Add: Railgun weapon technology	20.000	-
FY 2017 Accomplishments: N/A		
Congressional Add: Medium caliber lightweight composite barrel technology	5.000	-
FY 2017 Accomplishments: N/A		
Congressional Add: Guided tank fired round development for high mobility targets	8.500	-
FY 2017 Accomplishments: N/A		
Congressional Add: Armament systems concepts	5.000	-
FY 2017 Accomplishments: N/A		
Congressional Add: hybrid projectile technology	5.000	-
FY 2017 Accomplishments: N/A		
Congressional Adds Subtotals	66.500	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H1A / *WEAPONS & MUNITIONS TECH PROGRAM INITIATIVE*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602624A / *Weapons and Munitions Technology*	Project (Number/Name) H28 / *Warheads/ Energetics Technologies*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H28: *Warheads/ Energetics Technologies*	-	16.282	14.647	22.201	-	22.201	25.873	28.383	33.287	33.952	0.000	174.625

A. Mission Description and Budget Item Justification

This Project investigates and designs enabling warhead and energetic technologies such as novel warhead architectures, new propellant techniques, and high-density explosives to produce smaller, lighter, more effective, multi-role warheads, flare and pyrotechnic countermeasures, and novel approaches for ammunition demilitarization and combat in complex environments.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Scalable Warhead Technology	5.771	5.250	6.001
Description: This effort designs scalable and adaptive explosives and reactive materials technology for either gun or missile-launched weapons and munitions that can deliver a broad spectrum of effects with reduced collateral damage. In addition, this effort will facilitate the design and development of improved area clearance technologies.			
FY 2018 Plans: Mature warheads to higher levels of technology readiness through the iterative design and development process and validate previous work in modeling and simulation. Among these are novel designs that can enable multi-role munitions (e.g. Counter Rocket, Artillery, and Mortar, Counter Unmanned Aircraft System) such as shaped charge (SC) and multi explosively formed penetrators (MEFP?s) developed to address emerging threats. In addition, further designs in controlled and scalable blast fragmentation are pursued to concentrate lethality while reducing collateral damage. Continue the design process to provide lethality solutions to cluster munition replacements as well as continue maturing novel area clearance concepts; validate component technologies in a relevant environment.			
FY 2019 Plans: Will mature and down select various warhead components (mini SC liners, mini EFPs and multi-EFPs) for insertion into follow-on 6.3 efforts; validate effectiveness of selected concepts against simulated and actual threats.			
FY 2018 to FY 2019 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H28 / *Warheads/ Energetics Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Increase due to maturation of technologies for mini shaped charge liners, mini-explosively formed penetrators, and multi-explosively formed penetrators.			
Title: Advanced Energetics (formerly named Explosives Research) ***Description:*** This effort develops advanced energetic materials and novel processing techniques for future explosives and propulsion applications that enable an increase in range, lethality, and utility of ammunitions. ***FY 2018 Plans:*** Conduct research to investigate a new class of energetic materials, amorphous energetics, capable of on-demand activation for improved sensitivity and performance; investigate the synthesis of energetic materials tailored to additive manufacturing applications; design explosives charges with integrated electronics; model next-generation gun-propulsion charge design concepts achievable as a result of additive manufacturing capabilities; conduct research with advanced processing methods to synthesize energetic materials in safer, more efficient and environmentally-conscious manners. ***FY 2019 Plans:*** Will mature technologies focused in nano-energetics designs for use in melt-cast formulations; will mature the polymer kinetics for amorphous energetics; will investigate next-generation melt-cast and cast-cure ingredients for higher energy formulations; will investigate reaction kinetics for ingredient synthesis applicable to advanced flow reactors; will design and develop processing parameters necessary to produce energetic materials for additive manufacturing; will develop novel modeling and simulation tools required to accurately predict energetic materials performance in novel and unique geometries. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase due to research into advanced nano energetics and mature new formulations for the next generation energetics.	7.526	6.349	8.338
Title: Tunable Pyrotechnics ***Description:*** This effort develops smoke and flare countermeasure for passive protection for ground and air combat platforms, and hand held signals for illumination and signaling. These capabilities will increase warfighter and aircraft survivability. ***FY 2018 Plans:*** Integrate and test designs for dazzler Counter Measure (CM) for both night time and day time solutions; refine M&S for reliability to evaluate if requirements can be met; produce scaled-up quantities for cloud countermeasure for down selected flare formulations; investigate and verify effectiveness of formulations; mature formulations of ASCM to obtain effectiveness data; validate cloud CM to Technology Readiness Level 5 (TRL-5). ***FY 2019 Plans:***	2.985	2.048	3.721

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H28 / *Warheads/ Energetics Technologies*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Will develop an integrated solution for the Dazzler Counter Measure to include new pyrotechnic formulations; will develop and modify ASCM formulations based on static and functional tests to assess viability of technology candidates; will investigate new countermeasure designs in the electromagnetic (EM) spectrum to address emerging threats. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase due to maturation of complex pyrotechnic formulations to address future threat.			
Title: Novel Demilitarization Technologies ***Description:*** This effort develops smoke and flare countermeasure for passive protection for ground and air combat platforms, and hand held signals for illumination and signaling. These capabilities will increase warfighter and aircraft survivability ***FY 2018 Plans:*** Investigate contained release agents for weapons demilitarization; design demilitarization-ready ammunition using embedded agents that modify explosives on-demand and render munitions safe and unusable for military purposes. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort completed in FY18.	-	1.000	-
Title: Advanced Warheads ***Description:*** This effort explores multiple pathways to enhance lethal efforts for future warheads against emerging peer/near peer target sets. Investigates synergistic effects of novel micro warheads using advance materials. ***FY 2019 Plans:*** Will characterize new family of materials for designs of novel micro warheads to achieve fragmentation, explosively formed penetrators (EFP) and shaped charge effects; will conduct parametric study to establish the performance and lethal effects of novel warhead designs. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort begins in FY19.	-	-	4.141
Accomplishments/Planned Programs Subtotals	16.282	14.647	22.201

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602624A / *Weapons and Munitions Technology*	**Project (Number/Name)** H28 / *Warheads/ Energetics Technologies*

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602705A / *Electronics and Electronic Devices*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	72.979	58.352	58.283	-	58.283	57.741	59.224	59.519	63.663	0.000	429.761
EM4: *Electric Component Technologies (CA)*	-	18.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	18.000
EM8: *High Power And Energy Component Technology*	-	11.000	10.632	12.584	-	12.584	13.150	13.386	13.684	16.316	0.000	90.752
H11: *Tactical And Component Power Technology*	-	8.396	8.332	7.658	-	7.658	7.854	8.050	7.017	5.181	0.000	52.488
H17: *Flexible Display Center*	-	2.266	2.143	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.409
H94: *Elec & Electronic Dev*	-	33.317	37.245	38.041	-	38.041	36.737	37.788	38.818	42.166	0.000	264.112

A. Mission Description and Budget Item Justification

This Program Element (PE) designs and evaluates power components and power management technologies, frequency control and timing devices, high power microwave devices, display technologies, and electronic components. The applied research on these technologies enable the ability to perform precision deep fires against critical mobile and fixed targets; investigate all-weather, day or night, theater air defense against advanced enemy missiles and aircraft; as well as investigate enhanced communications and target acquisition through support of capabilities such as autonomous missile systems, advanced land combat vehicles, smart anti-tank munitions, electric weapons, secure jam-resistant communications, automatic target recognition, foliage-penetrating radar, and combat identification. Project EM8 designs and evaluates high-power electronic components and technologies. Project H11 designs, investigates and validates advanced power and energy technologies (batteries, alternative energy and hybrids) and power management and distribution techniques (wireless power, intelligent power management). Project H17 designs and evaluates flexible displays in conjunction with the Flexible Display Center. Project H94 researches and evaluates electronic component technologies such as photonics, micro electromechanical systems, imaging laser radar, magnetic materials, ferroelectrics, microwave and millimeter-wave components, and electromechanical systems.

Work in this PE complements and is fully coordinated with efforts in PE 0602120A (Sensors and Electronic Survivability), PE 0602307A (Advanced Weapons Technology), PE 0602709A (Night Vision Technology), PE 0602782A (Command, Control, Communications Technology), PE 0602783A (Computer and Software Technology), PE 0603001A (Warfighter Advanced Technology), PE 0603004A (Weapons and Munitions Advanced Technology), and PE 0603772A (Advanced Tactical Computer Science and Sensor Technology).

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

Work is performed by the Army Research, Development, and Engineering Command (RDECOM).

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602705A *I Electronics and Electronic Devices*	

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	56.322	58.352	59.780	-	59.780
Current President's Budget	72.979	58.352	58.283	-	58.283
Total Adjustments	16.657	0.000	-1.497	-	-1.497
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	18.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.326	-			
• Adjustments to Budget Years	-	-	-1.497	-	-1.497
• FFRDC	-0.017	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: EM4: *Electric Component Technologies (CA)*		
Congressional Add: *Silicon Carbide (SiC) Research-Army Research Laboratory*	10.000	-
Congressional Add: *Tactical and component power technology*	2.000	-
Congressional Add: *Payload agnostic unmanned aerial systems*	4.000	-
Congressional Add: *Flexible printable electronics*	2.000	-
Congressional Add Subtotals for Project: EM4	18.000	-
Congressional Add Totals for all Projects	18.000	-

Change Summary Explanation

FY17 Congressional increase in EM4 Electric Component Technologies

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / *Electronics and Electronic Devices*	Project (Number/Name) EM4 / *Electric Component Technologies (CA)*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
EM4: *Electric Component Technologies (CA)*	-	18.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	18.000

Note

Congressional increases for tactical and component power technology ($2M); Payload agnostic unmanned aerial systems ($4M); Silicon carbide research ($10M); Flexible printable electronics ($2M)

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Electronic Component applied research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Silicon Carbide (SiC) Research-Army Research Laboratory ***FY 2017 Accomplishments:*** N/A	10.000	-
Congressional Add: Tactical and component power technology ***FY 2017 Accomplishments:*** N/A	2.000	-
Congressional Add: Payload agnostic unmanned aerial systems ***FY 2017 Accomplishments:*** N/A	4.000	-
Congressional Add: Flexible printable electronics ***FY 2017 Accomplishments:*** N/A	2.000	-
Congressional Adds Subtotals	18.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / *Electronics and Electronic Devices*	Project (Number/Name) EM8 / *High Power And Energy Component Technology*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
EM8: *High Power And Energy Component Technology*	-	11.000	10.632	12.584	-	12.584	13.150	13.386	13.684	16.316	0.000	90.752

A. Mission Description and Budget Item Justification

This Project provides for the research, development, and evaluation of high-power electronic components, materials, and related technologies. These technologies have application in compact and efficient power conversion, conditioning, and management sub-systems; energy storage and conversion devices; radio frequency (RF)/ microwave and solid-state laser directed energy weapons (DEW); traditional and non-traditional RF and laser electronic attack; and RF photonics. All project elements are coordinated with, and as appropriate leveraged by, DEW and power/energy programs in the Air Force, Navy, High Energy Laser Joint Technology Office, Defense Threat Reduction Agency, national labs, university consortia, and relevant industry and foreign partners. The products of this research are required by developers of Army and Department of Defense (DoD) systems to evolve traditional (mechanical-based) sub-systems such as geared transmissions, plate armor, and kinetic projectiles to electrically-based ones. These products will provide the Soldier enhanced survivability and lethality through increased power management and energy savings as well as new fighting capabilities offered only by electrical power.

This Project sustains Army science and technology efforts supporting the Ground Maneuver, Lethality, Soldier and Command, Control, Communications and Intelligence Portfolios.

The work in this Project is coordinated with the Army Tank and Automotive Research, Development, and Engineering Center (TARDEC); Armaments Research, Development, and Engineering Center (ARDEC); the Army Aviation and Missile Research, Development, and Engineering Center (AMRDEC); and the Army Communications-Electronics Research, Development, and Engineering Center (CERDEC); and the United States Army Space and Missile Defense Command/Army Forces Strategic Command (USASMDC/ARSTRAT).

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Advanced Solid-State Laser Technology and Integrated Photonic Technologies	2.000	2.006	2.000
Description: Research novel solid-state laser concepts, architectures, and components with the goal of providing advanced laser technology to Army directed energy weapon and tactical laser developers. Exploit breakthroughs in laser technology, develop and employ innovative laser gain material, and utilize photonics to meet the stringent weight/volume requirements for Army platforms, especially to enhance and improve the generation, transmission, reception, and processing of radio frequency (RF) signals. Applied laser research will be conducted in close collaboration with domestic and foreign material vendors, university researchers, and major laser diode manufacturers			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** EM8 / *High Power And Energy Component Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2018 Plans: Investigate innovative glass fiber laser architectures and bulk solid state laser materials and designs best suited for high energy per pulse operation with emphasis on low size, weight and power (SWAP) for applications including track illuminator lasers for directed energy weapons, Joule-class pulsed in-band Midwave-Infrared (MWIR) sources for imaging sensor defeat, and Longwave Infrared (LWIR) illuminators for operation in degraded visual environments; and develop structures, devices, and architectures to enable optical phased arrays capable of handling high peak power transmission and low loss reception. ***FY 2019 Plans:*** Will investigate innovative fully crystalline fiber designs, in particular, the ?crystalline core/crystalline cladding? design (a.k.a. CCCC or C4) developed to enable high energy laser power scaling out of single fiber laser aperture to >10X compared to the current state-of-the-art; will explore alternative Raman fiber designs for power scaling of direct diode cladding pumped Raman fiber lasers; and will develop structures, devices, and architectures to enable optical phased arrays capable of free space optical communications and ranging, and timing and position synchronization needed for mobile platforms. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Slight decrease due to reduced material cost.			
Title: Electronic Attack Technologies/Spectrum Sensing and Exploitation ***Description:*** This effort investigates emerging technologies related to electronic warfare (EW) applications, non-kinetic survivability/lethality, and emerging concepts of operation, such as cognitive radar, in the increasingly contested and congested electromagnetic environment, with the goal of enhancing the survivability/lethality of Army platforms through electronic attack (EA), electronic warfare support (ES), and electronic protection (EP). ***FY 2018 Plans:*** Develop multi-device waveform packages for counter unmanned aerial vehicle (CUAS) EA applications; explore distributed low-cost ES sensors and applications to enhance situational awareness and enable novel and precise EA capabilities; investigate next-generation radar EP performance in a complex electromagnetic environment; develop a cognitive spectrum sensing test-bed with advanced signal processing algorithms to support EP and RF spectrum exploitation objectives such as cognitive radar; and design and develop a full array of Cyber Electromagnetic Activities (CEMA) to investigate and validate the impact on developmental technologies and systems. ***FY 2019 Plans:*** Will develop neutralization techniques for autonomous vehicles; will investigate remote determination of target susceptibility; and will explore next-generation cognitive radar performance in realistic congested and contested spectral environment. Will	2.346	2.456	1.888

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** EM8 / *High Power And Energy Component Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
design and develop electronic attack (EA), electronic warfare support (ES), and electronic protection (EP) tools, techniques and methodologies for the highest priority Army systems and technologies for which electronic warfare is a critical threat. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decreased investments in spectrum sensing and exploitation to support new starts.			
Title: Electronic Components and Materials Research ***Description:*** Investigate compact, high-efficiency, high-temperature, and high-power component technologies (e.g., semiconductor, magnetic, and dielectric devices) for hybrid-electric propulsion, electric power generation and conversion, and smart micro-grid power distribution. Research addresses current and future Army-unique performance and operational requirements. ***FY 2018 Plans:*** Investigate ultrawide-bandgap power devices, architectures, and materials for power switching and distribution; modify and validate high voltage physics-based model to support gallium nitride (GaN)-based devices to provide better understanding of device operation and physics for improved reliability and performance; conduct analysis of motor operation at high frequency or high voltage to determine feasibility of high torque, low revolutions per minute (RPM) motors; investigate high frequency circuit topologies and, through modeling and component analysis, determine reliability and performance of circuit designs; investigate designs, materials, and additive manufacturing processes that enable low cost, high performance power device packaging; research aluminum (AlGaN) material properties leading to the growth of high speed transistors and diode devices; and explore AlGaN structures by varying substrate and epitaxial growth conditions. ***FY 2019 Plans:*** Will perform measurements on aluminum gallium nitride (AlGaN) high electron mobility transistor (HEMT) devices to demonstrate improved efficiencies and breakdown characteristics based on enhanced ohmic contacts, locally doped p-type regions using ion implantation, and AlGaN films grown on either high quality GaN or aluminum nitride (AlN) substrates; will refine high speed motor drive model and utilize model to study wide bandgap (WBG) device performance; will characterize WBG device performance using the motor test stand; and will investigate WBG devices for high speed high voltage motor drives and tactical power conversion. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased investments to advance the development of wide bandgap materials.	3.264	2.993	3.190
Title: Power System Components Integration and Control Research	3.390	3.177	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** EM8 / *High Power And Energy Component Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: Research the configuration of electronic components and control strategies required to achieve high-power density and high-efficiency power utilization in current and future platform sub-systems, and vehicle and micro-grid (installation) applications, to include the operation of military-specific power distribution topologies at the circuit and system levels. ***FY 2018 Plans:*** Investigate control methods and components that enable reconfigurable power conversion based on varying voltage to reduce the size, weight, and power of conductors in constrained applications; investigate concepts for compact and efficient high voltage power distribution topologies and control methodologies for continuous power applications; analyze and model concepts for significantly reducing the volume of high-voltage power conditioning circuits for use in projectiles and other compact lethality and protection systems; develop designs and control methodologies for novel, low voltage alternating current (AC) and direct current (DC) distributed control and storage technologies to improve energy efficiency of Army tactical energy networks; develop underpinning electric- and magnetic (E/H)-field technologies to support persistent power and energy monitoring of microgrid infrastructures and other systems; and develop algorithms to robustly characterize E/H-field multi-scale events in complex noise environments. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort ends in FY18.			
Title: Advanced Distributed Power for Autonomous Plaforms	-	-	1.506
Description: The effort investigates power distribution and conversion technologies to provide compact, efficient, and high power capabilities for electrical and electro-mechanical loads supporting both mobile and stationary platforms. High voltage and intelligent control methods will be coupled with the ongoing research in autonomy technologies to provide advanced performance enhancements in mobility and capabilities for these platforms. Research on innovative electric machines covering both electrical generation and motor technologies will focus on providing efficient, power dense, fault tolerant generation and mobility capabilities. Research addresses current and future Army-unique power delivery challenges in compact autonomous air and ground platforms. ***FY 2019 Plans:*** Will investigate power control topologies that provide low speed high torque motor operation; will explore power distribution and conversion methods for power generation that enhance fault tolerance and provide graceful degradation; will investigate high voltage switching and power packaging for application in conversion and distribution for autonomous platform mobility and power generation; and will perform research in compact power switching, conversion and distribution technologies to produce fast, high energy electrical discharge to provide unique mobility enhancements through application of high voltage phenomenology. ***FY 2018 to FY 2019 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** EM8 / *High Power And Energy Component Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
New focus area beginning in FY19.			
Title: RF Electronic Attack/Surveillance (Grey C3) ***Description:*** Investigate emerging technologies to enable electronic warfare (EW) applications in a grey environment. The goal is to develop software and reconfigurable radio frequency (RF) hardware in a handheld form factor for distributed electronic attack, distributed EW support, and communications. EW support includes advanced passive and active RF sensing. ***FY 2019 Plans:*** Will investigate techniques for distributed Electronic Attack (EA) and Electronic Warfare Support (ES) from handheld platforms; and will validate commercial off-the-shelf (COTS) and government off-the-shelf (GOTS) software-defined radios for use as surrogate development hardware. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** New focus area beginning in FY19.	-	-	2.000
Title: Vulnerability Analysis Methodology for CEMA threats ***Description:*** Research and investigate the optimum configuration of experimental and analysis methodology for separate and combined cyber and electromagnetic threat attack so as to better support and inform Army system designers, analysts, evaluators, and decision makers. ***FY 2019 Plans:*** Will design and develop a vulnerability analysis and susceptibility profile methodology based on current simulation and experimental methods for cyber and electromagnetic threats. Will investigate and validate methodology to improve Protect, Detect, React, and Restore assessments through automation and advanced analytics. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** New focus area beginning in FY19.	-	-	2.000
Accomplishments/Planned Programs Subtotals	11.000	10.632	12.584

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** EM8 / *High Power And Energy Component Technology*

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / *Electronics and Electronic Devices*	Project (Number/Name) H11 / *Tactical And Component Power Technology*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H11: *Tactical And Component Power Technology*	-	8.396	8.332	7.658	-	7.658	7.854	8.050	7.017	5.181	0.000	52.488

A. Mission Description and Budget Item Justification

This Project identifies, advances, and enhances emerging power generation, energy storage, and power management components and software. This Project researches advancements in enabling power management, rapid decision making, expeditionary maneuver, and distributed operations across the battlefield. This Project also researches materials and components to develop lightweight, higher capacity, safer and more efficient power technologies that will enable continuous and energy aware operations while on the move and across battlefield environments.

The cited work is consistent with S&T priorities of the U.S. Army Chief of Staff, the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Tactical Power Generation Technology	3.830	3.625	2.946
Description: This effort designs, investigates and validates Soldier-borne power generation and energy storage technologies in order to decrease Soldier load and power burden, and increase power capabilities by providing more energy to prolong mission run-time. This effort will investigate energy harvesting devices while on the move which will enable a continuous operations and reduced logistics for the Soldier. This effort will also investigate advanced hybrid battery chemistries for wearable, flexible battery designs.			
FY 2018 Plans: Investigate and evaluate improvements to generator component technologies in energy harvesting devices for power conversion efficiency and enable more power generation on the move for near NetZero (produces as much energy as it uses) operations; investigate advanced lithium primary and rechargeable battery chemistries that are low cost and have the potential to double the runtime of current battery technology; conduct lab experiments on advanced battery cells configured with new chemistries, electrodes and electrolytes to validate the stability of the formulation and improvements in capacity; develop cell components to further improve the usable capacity within the ballistic battery to enable 20+ hours of continuous power; investigate fuel reformation techniques along with advanced materials to develop a small form factor, multi-fueled, wearable power source.			
FY 2019 Plans: Will complete optimization of electromechanical component technology designs in kinetic energy harvesting devices for maximum power generation and conversion efficiency to enable continuous, distributed operations; continue investigation of power generating techniques with significant power densities including ultra-capacitor technology; complete the optimization and			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H11 / *Tactical And Component Power Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
integration of high voltage cathode materials into representative battery cells to validate designs and assess energy density advancements; complete the development of Silicon Anode and Lithium Sulfur cell materials for advanced lithium primary and rechargeable battery cell packs that enables a 2x improvement in performance; research novel chemistries and balance of plant materials for smaller, lighter, wearable / portable fueled power sources to enable continuous power generation and platoon battery charging. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Investment reduction in rechargeable battery chemistry research in order to support senior leader Network priorities.			
Title: Energy Informed Operations ***Description:*** This effort investigates power management technologies, components and systems to increase the efficiency of energy output, reduce weight and increase reliability, while increasing fuel and cost efficiency across battlefield environments. This effort funds research in control and interface standards for effective power management, novel power distribution techniques, situational awareness, predictive, and prognostic and diagnostics capabilities for tactical power missions. This effort will also investigate scalable brass board designs for power management and distribution in support of missions in the 60 kilowatt (kW) ? 360kW range. Work in this effort complements Program Element (PE) 0603772A/Project 101. ***FY 2018 Plans:*** Simulate power micro-grid architecture, standards and interface specification for controller software and expand and update interface specification for software and physical architecture design to more efficiently distribute and manage power across the battlefield based on results of simulation; explore a domain-based approach for standards for distributed micro-grid; investigate performance and design of smart power generation and distribution devices such as generators, inverters, distribution boxes, energy storage and renewable energy systems, that can be managed, monitored and controlled by Soldiers or autonomously to prioritize load, reduce fuel consumption and ensure reliable mission power based on a distributed, rather than a centralized control approach; design architecture and software to incorporate wireless data technologies for the purpose of reducing power loss, complexity of setup and startup, and weight in power distribution systems; investigate the use of secure wireless internet (WiFi) and power line carrier methods to transmit control and status signals; analyze novel wireless power transmission technologies such as far field (for distances over 0.25 kilometers) power transfer based on microwave and laser power transmission technologies. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort ends in FY18.	4.566	4.707	-
Title: Optimized Energy for C4ISR Platforms	-	-	4.712

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H11 / *Tactical And Component Power Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: This effort investigates power and thermal management associated with high power Command, Control, Communications, computers, Intelligence, Surveillance and Reconnaissance (C4ISR) capabilities on ground and air platforms enabling enhanced mobility and mission flexibility. This effort funds research to improve platform efficiency through the use of on-demand hybrid power architectures, while also researching ways to eliminate platform thermal constraints. This effort will also investigate very high density power sources and energy storage for high rate pulsed power, power management and thermal management for dynamic high rate pulsed power. Work in this effort complements Program Element (PE) 0603772A/Project 101. ***FY 2019 Plans:*** Will investigate power requirements for emerging C4ISR capabilities to include directed energy, lasers, high power sensors, and electromagnetic weapons; conduct analysis of size, weight and power requirements necessary to support these capabilities with unique very high density power sources and energy storage for high rate pulsed power; identify interface requirements and constraints for power system; investigate architectures and intelligent controls necessary to manage these loads; investigate and perform high resolution characterization of cyclical, step and high power load profiles likely to result from use of lasers or other high power, short duration burst technology; examine thermal implications and waste heat generated from inefficiencies in power conversation; explore hybrid energy storage technologies to support cyclical loads such as hybrid batteries or ultra-capacitor technology; determine duel use potential of microwave or laser power transmission technologies with other developmental operational uses; conduct experiments on wireless power transmission capabilities for laser power transmission; explore the use of intelligent control strategies for platform integrated power systems. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Investment to support C4ISR power requirements in support of Network/C3I senior leader priorities.			
Accomplishments/Planned Programs Subtotals	8.396	8.332	7.658

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / *Electronics and Electronic Devices*	Project (Number/Name) H17 / *Flexible Display Center*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H17: *Flexible Display Center*	-	2.266	2.143	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.409

A. Mission Description and Budget Item Justification

The flexible electronics program conducts applied research on the integration of electronics, power components, and sensors on non-traditional flexible substrates. The program builds upon two-dimensional (2D) flexible electronics to incorporate the integration of electronic components, power systems, and sensors into three-dimensional (3D) flexible architectures. The research includes electronic modeling, design, fabrication, and analysis. The applied research supports the demonstration of Army-relevant sensors on flexible substrates for Army applications such as monitoring of the human state.

This project supports Army science and technology efforts in the Command, Control, Communications and Intelligence portfolio.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Flexible Electronics Development (previously Flexible Display Center (FDC) and Flexible Electronics Development)	2.266	2.143	-
Description: The flexible electronics program is advancing applied research towards the integration of electronics, power components, and sensors on non-traditional flexible substrates and into three-dimensional (3D) architectures. ***FY 2018 Plans:*** Investigate hybrid 3D printed sensors with integrated silicon (Si) complementary metal-oxide-semiconductor (CMOS) electronics; investigate co-design of algorithms, power distribution, and 3D printed sensors and electronics for extended duration monitoring of soldier's physiological and environmental state; examine and develop noise resistant and computationally efficient algorithms coupled to distributed sensing and computation hardware to enable real-time estimate of the human physiological state; investigate hardware, algorithms, and architectures to enable efficient, robust physiological monitoring of individuals within small, distributed groups; and will develop silicon-fiber based liquid metal inductors; and develop and improve the fabrication process for stretchable gallium nitride (GaN) in silicon, which enables electronic monitoring of Soldiers? performance on or close to the skin without discomfort. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort ends in FY18.			
Accomplishments/Planned Programs Subtotals	2.266	2.143	-

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H17 / *Flexible Display Center*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602705A / *Electronics and Electronic Devices*	Project (Number/Name) H94 / *Elec & Electronic Dev*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H94: *Elec & Electronic Dev*	-	33.317	37.245	38.041	-	38.041	36.737	37.788	38.818	42.166	0.000	264.112

A. Mission Description and Budget Item Justification

This Project designs and characterizes electronics, electronic components, and electronic devices for Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) applications and battlefield power and energy applications. Significant areas of component research relevant to C4ISR include: antennas, millimeter wave components and imaging, micro- and nano-technology, eye-safe laser radar (LADAR), vision and sensor protection, infrared (IR) imaging, photonics, and prognostics and diagnostics. Areas of research relevant to power and energy include power and thermal management, micro-power generators and advanced batteries, fuel reformers, fuel cells for hybrid power sources, and photosynthetic routes to fuel and electricity.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Antennas, Microwave Components, and Millimeter Wave Imaging	4.707	5.733	5.681
Description: This effort designs, characterizes, and validates high performance antennas, microwave components, and software for multifunction radar, radio frequency (RF) sensing, and communication systems. Research areas include scanning techniques, broadbanding, beamforming, polarization, platform integration, and affordability. For microwave components, research areas include software defined radios, analog-to-digital conversion rates, bandwidth resolution, bit accuracy, circuit design and affordability.			
FY 2018 Plans: Develop an analytical methodology that will define key electrical parameters for antenna optimization; use this methodology to define electrical parameters in computer simulations; develop experimental antennas exploiting previous materials development work at ARL; investigate devices and materials for two-dimensional (2D) steering of millimeter-wave radar beams for applications such as helicopter collision avoidance in degraded visual environments; design, fabricate, and characterize gallium nitride (GaN)-based integrated circuits for multi-mode radar applications; examine techniques to achieve compact, linear RF front-end components to increase radar range and sensitivity; mature RF micro-electromechanical system (MEMS)-enabled electronics for			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H94 / *Elec & Electronic Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
cognitive and adaptable radio and electronic warfare systems; and investigate small, low-power sensors and control systems for use by Soldiers and in unmanned applications. ***FY 2019 Plans:*** Will perform in-situ simulations of low-profile antennas and propagation; integrate and characterize new antenna and RF electronics to improve the performance of the helicopter situational awareness radar and study the fusion of these radars with other hostile fire sensor modalities; enhance efforts for material driven antenna designs to include evolving antenna additive manufacturing through the investigation of higher dielectric feed stock and conductive printed metals; produce novel, complex and conformal multiband array designs that are not cost effective to produce with current commercial materials; design enabling components for transmitter architectures that supports complex digital modulations in the presence of very strong nonlinearities; study enabling devices and integrated circuits at millimeter-wave frequencies at the advent of 5G and newly competed spectrum; develop machine learning techniques/algorithms for RF modulation recognition. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Slight decrease due to maturity of MEMs-based electronics.			
Title: Advanced Micro and Nano Devices ***Description:*** This effort designs and characterizes micro- and nano-technology components for multi-functional and integrated radio frequency (RF) applications, micro-robotics, integrated energetics, control sensor interfaces, and sensors for improved battlefield situational awareness. Work being accomplished under PE 0601102A / Project H47 (Applied Physics Research) complements this effort. ***FY 2018 Plans:*** Explore 2D stacked electronic materials and tunable electronic properties for multifunctional integrated RF circuits; mature piezoelectric-enabled RF micro-electromechanical system (MEMS) components for cognitive and adaptable radio and electronic warfare systems; and investigate integration of on-chip energetic materials for low-cost electronic device protection. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort ends in FY18.	2.155	1.947	-
Title: Survivability for Wireless Tactical Networks (formerly Security and Survivability for Wireless Tactical Networks) ***Description:*** This effort researches, designs and implements protocols and algorithms for networks of physical devices and autonomous systems operating under severe energy and bandwidth constraints, and which are vulnerable to adversarial infiltration. The objective is to enhance the performance and survivability of these tactical wireless networks through improved monitoring and detection of network problems, resulting from both adversarial activity and the operating environment, and through proactive adaption of the computer and network routers to these dynamics. In FY 2019, realigned funds moved out of this effort	1.439	1.567	0.750

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H94 / *Elec & Electronic Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
remain in support of the Army science and technology (S&T) priorities (cyber) as identified at the December 2016 S&T Army Requirements Oversight Council by the Chief of Staff of the Army. ***FY 2018 Plans:*** Investigate and implement scheduling algorithms that dynamically adapt based on local- and network-wide conditions; investigate network capacity improvement techniques; and develop machine learning approaches for detecting, characterizing, diagnosing, and defeating potentially malicious activities in networks of physical devices and autonomous systems. ***FY 2019 Plans:*** Will investigate and develop cognitive networking algorithms that optimize media access control scheduling and network routing in resource constrained (e.g. energy, processing), congested and contested environments; implement energy and computationally efficient techniques to determine if resource constrained devices have been infiltrated and corrupted by an adversary; investigate approaches for adapting and optimizing communication modalities in response to adversarial activity; implement techniques for simulating and emulating large scale networks to enable analyzing the behavior of complex systems of networks in complex tactical operating environments. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Investments decreased due to development of technologies for anti-access/area denial.			
Title: Sensor Protection ***Description:*** This effort develops and characterizes materials for protection of electro-optic (EO) systems from lasers. ***FY 2018 Plans:*** Deposit electro-optical (EO) materials for protection on substrates with very high thermal conductivity to provide improved temperature control and reduced power consumption in fast EO shutter devices; and optimize active protection concepts in the infrared (IR) for improved speed and threat laser wavelength rejection. ***FY 2019 Plans:*** Will mature EO materials and supporting electronic components; validate speed and degree of protection of large-area EO shutters; conduct experiments to determine performance of tunable longwave IR filter designs. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase in investments to develop tunable electro-optical material - based filters.	2.780	2.914	4.925
Title: Applied Photonic and Optoelectronic Devices (formerly Hazardous Material Detection) ***Description:*** This effort models and develops materials and devices for the next generation Army sensor systems. Semiconductor materials and devices from ultraviolet (UV) to infrared (IR) with active and passive imaging capabilities will be modeled and	1.910	1.957	2.141

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
developed. This will allow the Soldier to maintain situational awareness day and night under cluttered battlefield conditions. Sources and detectors for next generation secure battlefield communication devices will also be developed. For asymmetric threats, chemical sensing devices will also be studied and developed. ***FY 2018 Plans:*** Characterize, and model mechanisms in semiconductor materials that can reduce thermal noise in IR devices and allow them to operate at higher temperatures, reducing the need for cryogenic cooling; model and simulate to improve IR system-level performance; model and develop energy efficient, compact semiconductor ultraviolet (UV) laser sources and detectors for short-range, non-line-of-sight communications; and develop interfaces to connect biochemical signal detection with on-chip photonics and electronics for improved detectors. ***FY 2019 Plans:*** Will conduct 3-D modeling of the device properties of mercury cadmium telluride semiconductor structures that utilize novel resonant architectures or carrier depletion techniques to reduce dark current and increase operating temperature of IR detectors and thereby reduce the need for cryogenic cooling; design and develop near ultraviolet laser sources based upon semi-polar and non-polar III-Nitride semiconductor heterostructures to enable compact and low cost ion-based quantum devices for networking; continue development and characterization of molecularly imprinted polymers as a chemical detection filter / concentrator for studying asymmetric threats. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased investments to support development of novel III-Nitride materials.			
Title: Power and Thermal Management for Small Systems ***Description:*** This effort investigates, designs, and fabricates micro-electromechanical system (MEMS)-based components to improve power generation and micro-cooling technology for both dismounted Soldier and future force applications. ***FY 2018 Plans:*** Improve the size, weight, and packaging of electronics with higher thermal handling characteristics; and utilize excess heat through thermal-to-electric conversion for more energy efficient electronics via new materials, device technologies and structures, as well as the use of novel physical phenomena. ***FY 2019 Plans:*** Will demonstrate integrated thermophotovoltaic generator with overall system efficiency improved through an integrated heat recuperator and demonstrate multiple "simple" fuels, including single component hydrocarbons and surrogate fuels for more	2.026	0.891	0.903

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
complex fuels like JP-8; use experimental results to validate models developed as part of this objective for the different fuel and catalyst material combinations. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase due to inflation.			
Title: Advanced Infrared Technology ***Description:*** This effort designs and characterizes materials, components, and focal plane arrays (FPAs) for the next generation of night vision systems, missile seekers, and general surveillance devices. Materials and devices investigated include mercury cadmium telluride (MCT) and resonant quantum well infrared photodetector (R-QWIP) arrays for the long-wave infrared (LWIR) spectral region with goals to increase the operating temperature and decrease the cost of FPAs. Additionally, modeling of infrared device performance, at both the device and system levels, is being performed for all major infrared systems (MCT, R-QWIP, indium antimonide (InSb), and strained layer superlattices) of importance to the community.	1.584	-	-
Title: Power and Energy ***Description:*** This research focuses on the design and characterization of chemistries, materials, and components for advanced batteries, fuel reformers, and fuel cells. Potential Army applications include hybrid power sources, smart munitions, hybrid electric vehicles, and Soldier power applications. Additionally, investigate the applicability of photosynthesis to provide fuel and electricity for Soldier power applications, and investigate silicon carbide (SiC) power module components that could enable compact, high efficiency, high temperature, and high power density converters for motor drive and pulse power applications. The research accomplished under PE 0601104A/Project VS2 (multi-scale modeling) complements this effort. ***FY 2018 Plans:*** Investigate the deactivation mechanism of hydrocarbon combustion catalysts through in-situ studies with advanced spectroscopy and electron microscopy and develop strategies to design highly active and durable catalyst materials for compact power generation; develop improved electrolytes for high voltage storage chemistries; optimize development of high voltage electrolytes, additives and cathodes for energy density and safety; improve rise time and duration of thermal batteries within size, weight and power (SWAP) constraints; and develop an acid-alkali fuel cell membrane electrode assembly. ***FY 2019 Plans:*** Will improve the efficiency of dual intercalation electrodes for inexpensive grid energy storage; investigate additives to limit dendrite formation of lithium metal batteries for high energy density rechargeable batteries; investigate all-solid-state chemistries for safe lithium batteries; analyze and interpret the results of the investigation of new methods for reduced aging improved duration of thermal batteries performed in FY18; determine through modeling or conducting experiments the performance of these methods; investigate nanocomposite non-noble catalysts and acid-alkaline bipolar membrane electrolyte interface and single cell	2.837	2.783	1.671

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H94 / *Elec & Electronic Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
performance; integrate semipermeable membrane materials and electrolytes via hybrid bi-cell and bipolar membrane technologies to address costs and balance-of-plant issues. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decrease in investments to support novel energy harvesting technologies.			
Title: Energy Harvesting ***Description:*** This research develops technologies to substantially reduce the number of batteries required to accomplish dismounted Soldier/Squad mission objectives, thereby significantly reducing Soldier-borne load and logistics requirements. Research will explore technologies to harvest electrical power by converting and storing energy via engineered structures and electronic bandgaps, micro-electromechanical system (MEMS)-based micro-scale power conversion, and heterogeneous 3D assembly of MEMS with other devices to enable efficient, distributed power conversion. Research explores novel paths to local fuel and energy production, including artificial photosynthesis, to extract hydrogen and electricity directly from water and sunlight. ***FY 2018 Plans:*** Develop photo-corrosion mitigation strategies that enable stable photo-electrolysis to produce hydrogen gas; develop catalysis process for faster electron transfer; create engineered polarization in gallium nitride devices; develop highly mismatched alloy material with good electronic and optical properties for water molecule splitting; develop spectral emission/transmission with spectrally tailored bandgap cells to increase far-field thermo-photovoltaic conversion efficiency; and develop polariton modes between emitter and cell to increase conversion efficiency and power density. ***FY 2019 Plans:*** Will incorporate broad-angle anti-reflection / rear surface light trapping structure matched to response spectrum of optimized hybrid quantum-mechanical based solar cell; investigate novel thermal energy harvesting including elastocalorics and pyroelectrics; develop plasmonically enhanced water and urea splitting device; develop the capability of enhancing catalytic reactions using infrared radiation; develop antimonide-doped gallium nitride water splitting device; demonstrate methanol production from Carbon Dioxide (CO_2) through reduction processes in the present of sunlight. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Enhanced investments in energy harvesting to develop tactical-unit energy independent solutions.	2.524	2.764	3.022
Title: Energy Efficient Electronics & Photonics ***Description:*** This effort addresses sustainment operations by unburdening the Soldier and reducing logistics requirements (e.g., fewer batteries) for communications, computing, and sensing. The objective is to improve the underlying energy efficiency of supply and demand for Soldier-portable and unattended sensor electronics to enable the dismounted Soldier to maintain communications, freedom of movement, and increase mission duration. The majority of the electronics power used by the	4.869	5.538	5.523

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H94 / *Elec & Electronic Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019

dismounted Soldier and by unattended sensors is attributable to radio frequency (RF) communications. In addition, freedom of movement and action during sustained and high tempo operations requires seamless battery recharging. To address these challenges, energy efficient electronics research includes RF circuits, devices, materials and wireless power distribution. Energy efficiency improvements will be developed and investigated in support of five key sensor and electronic areas: RF component devices, passively powered components, low-power, long-lived sources, wireless power transfer, and advanced battery chemistries. Additionally, materials and devices used for photonic applications, such as laser diodes and fiber lasers, will be studied and improved with an emphasis on overall size, weight, and power consumption efficiency gains.

FY 2018 Plans:

Explore heterogeneous integration of efficient III-V and II-VI semiconductor devices with leading edge process technology to enable small form-factor, highly linear RF circuits; examine digital back-end accelerators for implementing realistic communication waveforms at substantially reduced power; explore energy efficiency improvements by utilizing sub-threshold RF front-ends and high efficiency and high linearity analog components; investigate vertical and lateral carrier transport in semiconductor laser diode structures for the development of large area UV emitters; investigate the use of water-in-salt electrolytes to increase voltage window of supercapacitors and lithium-ion batteries and investigate the use of lithium sulfide (LiS) electrolytes for improved safety and improved energy storage; increase coulombic efficiency of dual intercalation electrodes for inexpensive grid energy storage; investigate additives to limit dendrite formation of lithium (Li) metal batteries for high energy density rechargeable batteries; investigate solid-state chemistries for safe Li batteries; investigate enhanced acoustically-coupled inductive wireless power transfer; reduce circuit power consumption through the design and fabrication of passively powered ambient sensors that enable zero power sleep mode for electronics; and develop extremely low power, intelligent power management for low power, long-life electronics.

FY 2019 Plans:

Will design and fabricate advanced node silicon and gallium nitride integrated circuits implementing Soldier Radio Waveform with 3X reduction in power draw; characterize carrier transport in semiconductor laser diode structures for the development of large area UV emitters; investigate processes to make 3-D electrode structures and investigate their effect on energy storage chemistry rates and ionic and electronic transports; investigate solid-state chemistries for safe lithium batteries; develop micro-electromechanical system (MEMS)-based and resonant RF sensors that can passively sense an RF signal while consuming < 10 nW of power for zero-power-consuming sleep mode electronics; determine the efficiency and power transfer limits of laser-to-pyroelectric wireless power transfer; explore acoustic power transfer with the ability to steer the acoustic beam source using arrays of acoustic transducers; design and develop near-ultraviolet laser sources based upon semi-polar and non-polar III-nitride semiconductor heterostructures to enable compact and low cost ion-based quantum devices for networking.

FY 2018 to FY 2019 Increase/Decrease Statement:

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Slight decrease in solid-state chemistries for safe lithium batteries.			
Title: Precision Measurement Technology for Contested Environments (Technologies for Anti Access / Area Denial)	2.512	2.941	2.983
Description: This research focuses on technologies that will enable precise and assured position, navigation and timing in global positioning system (GPS)-denied environments. The first objective of this research is to improve the size, weight, power, cost, and accuracy of current micro-Inertial Measurement Systems (IMS) through the design, and fabrication of micro-electromechanical system (MEMS) gyroscopes. The second objective is to develop an opto-electronic device that can be used as an ultra-precise local oscillator with improved stability for precision timing applications. The third objective is to address the ability to transmit jam-resistant precision timing signals by investigating the transmission of precision, synchronized timing signals over optical fibers and free-space using lasers. The fourth objective is to explore new radio frequency (RF) antenna concepts to extend the reach of IMS systems through pseudolites (ground-based substitutes for GPS satellites) and Soldier-borne systems, and to integrate multiple sensor modalities with the IMSs using sensor fusion techniques to reduce drift and increase positional accuracy. ***FY 2018 Plans:*** Characterize and analyze the residual frequency instability of a free-space, laser-based frequency transfer system that could be used to synchronize the Army's positioning, navigation and timing (PNT) devices in the absence of signals from GPS; mitigate environmentally induced noise sources to increase the timing stability on optical-electronic devices used for precision timing; investigate and develop MEMS inertial sensors, aiding sensors, and sensor fusion approaches to enable navigation-grade inertial measurement units for assured PNT; conduct simulations and explore development of a new technique for anti-jam GPS antennas distributed on the human body; develop methods for night-time three-dimensional reconstruction using thermal imagery for autonomous navigation and detection of medium to low emissivity surfaces (e.g., metals) at night to assist warfighters in locating manmade targets; and develop methods for real-time vegetation and land classification for aiding position/locality determination. ***FY 2019 Plans:*** Will develop robust object recognition, efficient simultaneous localization and mapping and interactive topological mapping methods and integrate them into low size, weight and power - Cost (SWAP-C) platforms; investigate novel information sources to passively locate humans in a complex and cluttered environment; design, fabricate and characterize an integrated MEMS and heterogeneous sensor solution for increased state estimation accuracy; improve PNT sensor fusion algorithms to include input from a heterogeneous array of aiding sensors in diverse environments; assemble wearable anti-jam GPS test- bed and study performance of body-distributed anti-jam GPS antennas in laboratory environment; design and characterize an asymmetric free-space optical link that uses a retro-reflector to measure the time delay between the transmitter and receiver and uses a modulated laser to develop low SWAP-C free-space optical time transfer techniques; investigate deep learning based approaches for perception, including scene, landmark and skyline recognition on computationally constrained platforms to enable geo-localization			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
without GPS; continue to develop and optimize material fabrication process for construction of environmentally stable Epsilon-Near-Zero oscillator materials and devices. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase due to inflation.			
Title: Anti-Tamper (AT) Technology Development ***Description:*** This effort develops tools, devices, and techniques to protect acquisition program systems and Critical Program Information (CPI) from adversarial threats. This work is executed by the Army Anti-Tamper Office located at the Aviation and Missile Research, Development and Engineering Center (AMRDEC) at Redstone Arsenal, AL. ***FY 2018 Plans:*** Mature Anti-Tamper (AT) tools, techniques and Intellectual Property (IP) for projects Rigor 1 and Rigor 1a; complete design of architecture-level AT integration technologies; continue development of threat-based sensors and secure processor Intellectual Property (IP); finalize contractual scope and tape-out for production of parts from Trusted Foundry; and receive and begin laboratory characterization of Rigor devices. ***FY 2019 Plans:*** Will develop threat-based sensors and secure processor Intellectual Property (IP) to support Rigor technology refresh; manufacture full Rigor 1b engineering models; complete laboratory characterization of Rigor 1b module; continue design and development of Rigor 1a module; develop Rigor 1a test-modules. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Enhanced investments to enable development of threat-based sensors.	3.974	5.025	6.050
Title: Cognitive Countermeasures Technology Development ***Description:*** This effort investigates and matures novel materials, components, and techniques to counter legacy and emerging threats to Army platforms. Emphasis will be placed on technologies and approaches to enable a robust, holistic countermeasure capability for target defeat, regardless of threat characteristics or guidance mode. ***FY 2018 Plans:*** Design, model, and characterize advanced laser materials and architectures with low size, weight, power and cost to improve pulsed laser output energy for aircraft survivability applications; investigate self-amplification of cascade Er:Y2O3 laser in Cr:ZnSe; and explore potential for radio frequency technologies to enable early warning threat detection. ***FY 2018 to FY 2019 Increase/Decrease Statement:***	-	2.010	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H94 / *Elec & Electronic Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Effort ends in FY18.			
Title: Technologies for Alternative Energy ***Description:*** Design and develop novel concepts of energy generation, energy capture materials, and component technologies for efficient conversion of ambient energy to electrical energy for use and storage. Design components to include microscale power devices for multimodal harvesting and efficient distributed power conversion. ***FY 2018 Plans:*** Investigate catalyzing carbon dioxide (CO2) to longer chain hydrocarbons for energy storage; design a photo-electrochemical cell for studying CO2 conversion to a fuel; develop cost effective energy storage solutions for microgrid applications to enable renewable resource integration; and develop advanced concepts that lead to the development of nanophotonic components for energy harvesting and optimization of hybrid nanostructured materials for more efficient solar energy conversion. ***FY 2019 Plans:*** Will develop improved thermoelectric materials, with a goal of >2X improvement (>10%) conversion efficiency for low temperature differences near 1000 C; assemble and validate battery or pseudo-capacitor packs for both electrochemical and safety. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase due to inflation.	-	1.175	1.191
Title: Quantum for Assured PNT in Zero-GPS Environments Acceleration ***Description:*** To develop quantum-based GPS-independent ultra-high precision PNT in a contested/gps denied battlespace for mission durations up to 7 days w/o external timing or position re-synchronization. This effort also enables Camouflage, Concealment, and Decoys (CC&D) in an Electronic Warfare (EW) space and synchronization of disaggregated platforms / fires across the battlefield for distributed sensing, processing, and lethal effect. ***FY 2019 Plans:*** Designing of integrated triaxial Microelectromechanical systems (MEMS) Internal measurement units (IMUs) with 3 orders of magnitude improvement in accuracy (goal TRL4 in FY21), develop approach/design for integrated photonics and quantum timing circuit that meets PNT timing requirements while meeting on Soldier SWAP-C goals, and to build optical time synchronization demonstration for FY20/TRL3 demonstration. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort supports C3I/Network senior leader priorities.	-	-	3.201
Accomplishments/Planned Programs Subtotals	33.317	37.245	38.041

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602705A / *Electronics and Electronic Devices*	**Project (Number/Name)** H94 / *Elec & Electronic Dev*

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602709A / *Night Vision Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	34.762	34.723	29.582	-	29.582	36.267	37.536	38.823	39.599	0.000	251.292
H95: *Night Vision And Electro-Optic Technology*	-	34.762	34.723	29.582	-	29.582	36.267	37.536	38.823	39.599	0.000	251.292

A. Mission Description and Budget Item Justification

This Program Element (PE) conducts applied research and investigates core night vision and electronic sensor components and software to improve the Army's capability to operate in all battlefield conditions. Technologies pursued in this PE have the potential to provide the Army with new, or enhanced, capabilities to detect and identify targets farther on the battlefield, operate in obscured conditions, maintain a higher degree of situational understanding (SU), and operate autonomously. Project H95 advances infrared (IR) sensor technologies, investigates sensor materials, designs advanced multi-function lasers for marking, targeting, designation, wind-sensing, and range finding, and develops models and simulations for validating advanced sensor technologies. Project K90 funds Congressional special interest items.

Work in this PE is fully coordinated with PE 0602120A (Sensors and Electronic Survivability), PE 0602705A (Electronics and Electronic Devices), PE 0602712A (Countermine Technology), PE 0603606A (Landmine Warfare and Barrier Advanced Technology), PE 0603710A (Night Vision Advanced Technology), and PE 060708045 (End Item Industrial Preparedness Activities).

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

Work in this PE is performed by the United States (U.S.) Army Research, Development, and Engineering Command (RDECOM).

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	36.079	34.723	35.005	-	35.005
Current President's Budget	34.762	34.723	29.582	-	29.582
Total Adjustments	-1.317	0.000	-5.423	-	-5.423
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.300	-			
• Adjustments to Budget Years	-	-	-5.423	-	-5.423
• FFRDC	-0.017	-	-	-	-

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army	Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*

Change Summary Explanation

Reduce Three dimensional micro-electronics for Night Vision Sensors in H95 to fund higher Army priorities in communications and networks.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602709A / *Night Vision Technology*	Project (Number/Name) H95 / *Night Vision And Electro-Optic Technology*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H95: *Night Vision And Electro-Optic Technology*	-	34.762	34.723	29.582	-	29.582	36.267	37.536	38.823	39.599	0.000	251.292

A. Mission Description and Budget Item Justification

This Project conducts applied research and develops component technologies that enable improved Reconnaissance, Surveillance, Target Acquisition (RSTA), and situational understanding (SU). Technologies include novel focal plane arrays (FPAs), lasers, and electronics. It also includes modeling and simulation to predict performance and to determine operational effectiveness of these technologies. Research focuses on infrared (IR) FPAs necessary to search, identify and track targets in all day/night visibility and battlefield conditions and to improve standoff detection in all operational environments. This Project designs, fabricates, and validates large format IR FPAs for sensors to simultaneously provide wide area viewing and the high resolution imagery for situational understanding, persistent surveillance, and hostile fire detection. This Project investigates and designs novel sensor electronics such as Digital Read Out Integrated Circuits (DROICs) to enable multifunction sensing. This Project also investigates and matures new semiconductor materials formed by a combination of elements from the periodic table. In addition, this Project develops algorithms for enhanced IR functionality, which provides the ability to perform detection and identification at extended ranges, as well as the ability to detect deeply buried targets. The reduction of size, weight and power - Cost (SWaP-C) is a key research objective for all efforts.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Distributed Aided Target Recognition (AiTR) Evaluation Center of Excellence	2.486	2.586	-
Description: This effort investigates a virtual, distributed capability to interactively process both real and simulated three-dimensional (3D) multispectral scenes for Defense-wide applications. Automatic target recognition (ATR) and AiTR algorithms are evaluated against realistic operational scenarios, to include roadside threats/explosively formed projectiles, in aided or fully autonomous Reconnaissance, Surveillance, Target Acquisition (RSTA) missions.			
FY 2018 Plans: Investigate new algorithms for situational understanding and threat awareness in all environments through hostile fire detection and location and obstacle avoidance; validate framework for image processing techniques that ingest multiple types of data from networks to increase Pd/FAR rates on multiple targets; assess algorithm performance against realistic operational scenarios and validate correlation processing of multiple types of multispectral two-dimensional (2D) and three-dimensional (3D) data of multiple targets to increase Pd while reducing the FAR using a cognitive image processing frame work.			
FY 2018 to FY 2019 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*	**Project (Number/Name)** H95 / *Night Vision And Electro-Optic Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
This program ended in FY18			
Title: Sensor Modeling and Simulation Technology ***Description:*** This effort investigates, verifies, and validates sensor engineering models, measurement techniques, and simulations. The goal is to improve the fidelity and adaptability of modeling and simulation capabilities for Warfighter training, sensor system analysis, and identification and assessment of phenomenology associated with imaging technologies and the calibration of imaging technologies. ***FY 2018 Plans:*** Research, develop, and validate Electro-optic/Infrared (EO/IR) sensor performance models and simulations for computer-aided prototyping and augmented reality applications through field data collection, lab measurements, human signature exploitation, and algorithm development; research and develop robust and comprehensive measures of target acquisition performance; validate with lab measurements; leverage commercial gaming simulation technologies and augmented reality as a means to increase situational understanding. ***FY 2019 Plans:*** Will continue to research and validate methods to model and simulate Electro-optic/Infrared (EO/IR) system performance for computer-aided prototyping and augmented reality applications through field data collection, lab measurements, simulation, signature, and algorithm research; will research methods to model emerging active and passive EO/IR technologies, applications, and threats such as hostile fire and unattended aerial systems to contribute to sensor system design; will investigate and validate target acquisition performance measures to address EO/IR sensor signature countermeasures; will investigate the application of commercial gaming technologies and augmented reality for modeling and simulation tools to create a rapid ability to assess EO/IR system designs. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY19 funding decrease to meet decreased objectives in FY2019 Base Plans which includes less field tests.	4.931	5.110	4.829
Title: Advanced Multifunction Laser Technology ***Description:*** This effort investigates technologies for a new class of multi-wavelength laser modules which will have the ability to replace multiple laser targeting systems and reduce the size, weight, and power (SWaP) of current devices. The goal is to achieve a single housing, electronics board, power supply, and telescope for all applications to provide a reduction in the SWaP of multi-function laser systems. The objective is to develop a laser with higher efficiency and lower volume than existing pulsed Mid-wave Infrared (MWIR) and Long-wave Infrared (LWIR) lasers, which will be used for threat sensor detection and active imaging in degraded visual environments. ***FY 2018 Plans:***	4.446	5.037	5.192

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*	**Project (Number/Name)** H95 / *Night Vision And Electro-Optic Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Conduct investigations of various MWIR laser configurations for threat sensor detection; validate and compare performance of different laser breadboards, including bulk solid state and fiber based pump lasers for frequency conversion, compare different frequency conversion techniques for efficient generation of MWIR; and perform trade studies of LWIR laser designs, and select best approach for implementation and further evaluation. ***FY 2019 Plans:*** Will complete investigation and perform down select of a MWIR laser configuration for threat sensor detection based on performance by different selected laser breadboards; will identify the highest performing frequency conversion techniques for electrical efficiency; will design and develop a lightweight and low power brass-board laser with greater than five Watts of power. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase due to inflation adjustment			
Title: Advanced Structures for Cooled Infrared Sensors ***Description:*** This effort researches detector materials and substrates for infrared (IR) sensors. This effort investigates and improves III-V materials (materials formed by a combination of elements from Groups III and V of the periodic table) and II-VI material (materials formed by a combination of elements from Groups II and VI of the periodic table), to provide low cost, large format, high quality imaging sensors. The emphasis of this effort is on reducing material defects and increasing reliability by developing new ways to prepare and treat the substrates, new designs, and new methods of growing the structures. The goal of this effort is to develop cost effective components for high definition Army IR sensors.	5.520	-	-
Title: Three-Dimensional Micro-Electronics for Night Vision Sensors ***Description:*** The goal of this effort is to investigate new, microelectronics, reconfigurable optics, and display technologies to interface with emerging 3D electronics processing. The ability to actively reconfigure optical elements will require investigation of new materials and lens designs to enable real time optical refocusing and extended fields of view. Micro-display technology will benefit from new integrated microelectronics by use of new and improved display materials which operate at lower powers and enable all weather, day/night visualization. ***FY 2018 Plans:*** Validate range performance of reconfigurable optical elements in sensor objectives and augmented reality display optics while maintaining optimized overlay of display and real scene; conduct investigation of suitability of novel optical element surface treatments for high optical throughput; mature high resolution displays for targeting and maneuver; validate optical components through bench top end-to-end testing. ***FY 2018 to FY 2019 Increase/Decrease Statement:***	5.836	6.076	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*	**Project (Number/Name)** H95 / *Night Vision And Electro-Optic Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Eliminate in FY19 in order to align funds to meet higher Army priorities.			
Title: Multi-Function Digital Readout Integrated Circuits for Cooled and Uncooled Focal Plane Arrays ***Description:*** The objective of this effort is the development of advanced 2-Dimensional (2D) and 3-Dimensional (3D) Digital Readout Integrated Circuits (DROICs) to replace legacy 2D analog ROICs. This effort will investigate and design a digital readout architecture optimized for large format, high resolution infrared (IR) focal plane arrays (FPAs) through the use of modeling, analysis, and simulations. This enabling technology will bring substantial advancements to IR imaging capabilities. ***FY 2018 Plans:*** Fabricate multi-layer Readout Integrated Circuits (ROIC) to significantly increase ability to storage of charge in a very small pixel area; validate new ROICs and arrays with increased dynamic range capability over legacy cooled imaging sensors; refine designs of digital ROIC circuitry for uncooled sensors; produce initial test structures for laboratory validation of designs. ***FY 2019 Plans:*** Will investigate and conduct experiments to validate real-time processing that will put multiple functions into a small package, while allowing for an on-the-move capability; will develop an on-chip non-uniformity correction (NUC) that demonstrates high frame rate dynamic motion compensation and on-chip stabilization IR imagery for improved dynamic range in a compact package. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding increased to FY19 in order to meet Army priority of multifunction sensors	6.645	6.334	7.445
Title: Computational Imaging ***Description:*** This effort develops component technology designed to increase battle space awareness, threat detection, and target identification (ID) by using a methodology of computation algorithms and optics combined with display and vision processing. The objective is to provide extended range, multi-spectral imaging capability, with reductions to the size, weight and cost (SWaC), for the individual warfighter. This effort will leverage work accomplished under Multi-Function Digital Readout Integrated Circuits (DROICs) for Cooled and Uncooled Focal Plane Arrays (FPAs) to provide improved mounted and dismounted Soldier situational understanding in urban and complex terrain under low light and visibility conditions. In FY19 a portion of funding is realigned to support a new effort in Embedded Processing for Autonomous Systems to meet Chief Staff of the Army (CSA) priorities. ***FY 2018 Plans:***	4.898	4.413	2.210

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*	**Project (Number/Name)** H95 / *Night Vision And Electro-Optic Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Investigate novel optics, sensors, and processing approaches for day/night visualization; conduct experiments in 3D scene visualization with compact infrared sensors; validate predicted algorithm performance for threat detection and sensor localization; begin development of new optic for performing real-time detection and localization operations ***FY 2019 Plans:*** Will design novel optics, sensors, and processing approaches for day/night visualization; will conduct experiments of computational algorithms and optics combined with display and vision processing to identify improvements in target discrimination and visualization; will validate new optics for performing real-time detection. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY19 funding decrease to increase efforts in embedded processing for autonomous sensors			
Title: High Sensitivity High Speed Uncooled Longwave Infrared (UCIR) Technology ***Description:*** This effort develops a new class of uncooled high sensitivity/high speed infrared (IR) imaging sensors to enable applications such as Hostile Fire Indication (HFI), Improvised Explosive Device (IED) and disturbed earth detection, driving/ pilotage guidance, and 360? situational awareness on all platforms. ***FY 2018 Plans:*** Conduct experiments on new materials and structure designs; produce initial test arrays based on the new materials; incorporate advances in Digital Read Out Integrated Circuits (DROICs) designs to enable sensitivity and dynamic range increases over currently available uncooled Long-wave Infrared (LWIR) technology. ***FY 2019 Plans:*** Will continue to conduct experiments and validate new class of highly sensitive uncooled infrared imaging arrays; will design high-dynamic range speed Readout Integrated Circuits (ROIC) and leverage advancing commercial foundry processes. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Minor change in FY19 funding decrease for personnel	-	5.167	5.135
Title: Embedded Processing for Autonomous Sensors ***Description:*** This effort develops signal and image processing algorithms at the sensor to provide actionable information in contextually relevant manner to the decision maker. ***FY 2019 Plans:*** Will conduct market research on signal and image processing algorithms for autonomous applications; will investigate novel techniques for improving signal and image processing algorithms to perform functions such as scene labeling, and data	-	-	4.771

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602709A / *Night Vision Technology*	**Project (Number/Name)** H95 / *Night Vision And Electro-Optic Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
association to enable autonomous functions; will research innovative approaches for data management and fusion which reduce information processing time. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** This is a new effort that is started in FY19			
Accomplishments/Planned Programs Subtotals	34.762	34.723	29.582

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602712A / *Countermine Systems*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	29.495	26.190	21.244	-	21.244	22.914	23.366	23.895	24.326	0.000	171.430
H24: *Countermine Tech*	-	20.038	20.453	15.248	-	15.248	16.126	16.484	16.823	17.112	0.000	122.284
H35: *Camouflage & Counter-Recon Tech*	-	5.457	5.737	5.996	-	5.996	6.788	6.882	7.072	7.214	0.000	45.146
HB2: *COUNTERMINE COMPONENT TECHNOLOGY (CA)*	-	4.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.000

A. Mission Description and Budget Item Justification

This Program Element (PE) investigates, designs, and develops technologies to improve counter explosive hazard detection, signature management, and counter-sensor capabilities. Focus areas are sensor components, sub-components, and software algorithms to improve detection of mines and explosive threats; novel methods to defeat mines and explosive threats; and signature management technologies to reduce the reconnaissance capabilities of enemy forces. The technologies being investigated are for both mounted and dismounted applications. Project H24 investigates state of the art counter explosive hazard technologies to accurately detect and neutralize threats with a high probability, reduce false alarms, and enable an increased operational tempo. Project H35 designs and develops advanced sensor protection, signature management, and deception techniques for masking friendly force capabilities and intentions. Project HB2 funds Congressional special interest items.

Work in this PE is related to and fully coordinated with PE 0602120A (Sensors and Electronic Survivability), PE 0602622A (Chemical, Smoke and Equipment Defeating Technology), PE 0602624A (Weapons and Munitions Technology), PE 0602709A (Night Vision Technology), PE 0602784A (Military Engineering Technology), PE 0603004A (Weapons and Munitions Advanced Technology), PE 0603606A (Landmine Warfare and Barrier Advanced Technology), and PE 0603710A (Night Vision Advanced Technology).

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

Work in this PE is performed by the United States (U.S.) Army Research, Development and Engineering Command (RDECOM).

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army	Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602712A *I Countermine Systems*

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	26.497	26.190	25.111	-	25.111
Current President's Budget	29.495	26.190	21.244	-	21.244
Total Adjustments	2.998	0.000	-3.867	-	-3.867
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	4.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.989	-			
• Adjustments to Budget Years	-	-	-3.867	-	-3.867
• FFRDC	-0.013	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: HB2: *COUNTERMINE COMPONENT TECHNOLOGY (CA)*		
Congressional Add: *Program Increase*	4.000	-
Congressional Add Subtotals for Project: HB2	4.000	-
Congressional Add Totals for all Projects	4.000	-

Change Summary Explanation

Reduce countermine technology research in H24 and camouflage technologies in H35 to fund higher Army priorities in communications and networks.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602712A / *Countermine Systems*	Project (Number/Name) H24 / *Countermine Tech*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H24: *Countermine Tech*	-	20.038	20.453	15.248	-	15.248	16.126	16.484	16.823	17.112	0.000	122.284

A. Mission Description and Budget Item Justification

This Project investigates, designs, and develops new technology components, sub-components, and software algorithms for detection, discrimination, and neutralization of individual mines, minefields, and other explosive threats. The goals of this Project are to accurately detect threats with a high probability, reduce false alarms, and enable an increased operational tempo.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Standoff Sensors for Explosive Hazard Detection	10.116	11.155	11.126
Description: This effort addresses the challenges of sensing and confirming potential in-road and roadside threats at standoff ranges. The effort focuses on understanding the phenomenologies that impact sensor design concepts and steer novel technologies that provide the primary means for detecting anomalies. The result is higher-confidence target detection and improved clutter/background filtering. Examples of candidate technologies include Forward Looking (FL) Electro-Optic/Infrared (EO/IR) and Ground Penetrating Radar (GPR) sensors, which are used to detect surface threats. ***FY 2018 Plans:*** Explore and develop novel sensing methods using multiple geometric configurations to enhance FL sensor modalities, including multi-look GPR, Long-wave Infrared (LWIR) and Visible; mature processing techniques by combining datasets from multiple sensor technologies in order to improve probability of detecting threats in complex environments; investigate new sensors for confirmation of threats for modular platforms; validate techniques to detect wires from standoff distances. ***FY 2019 Plans:*** Will design and validate novel sensors and processing approaches using advances in correlated FL and multistate GPR, vibration, and EO/IR sensors; will combine fused signal processing methods to better detect targets in the presence of clutter in the natural environment; will develop new processing techniques to improve detection capability of complementary sensors in varying environments; will investigate modular sensor components including unique radars, EO/IR sensors, wire detection techniques, and sensitive radio frequency technologies to remotely detect explosive hazards and indicators of emplacement such as command wires and initiation devices for application to small unmanned air and ground platforms. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Minor funding decrease due to personnel adjustments			
Title: Dismounted Explosive Hazard Detection Technology	7.218	6.508	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602712A / *Countermine Systems*	**Project (Number/Name)** H24 / *Countermine Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: This effort investigates emerging component technologies to enhance detection of explosive hazards, including metallic and non-metallic landmines, Improvised Explosive Devices (IEDs), Home Made Explosives (HMEs), and Explosively Formed Penetrators (EFPs). Emphasis is on increased coverage area, higher detection rates, and increased discrimination probabilities. Technologies that provide low Size, Weight, and Power (SWaP) solutions are considered and studied to ensure solutions are viable for Soldier-portable applications. This effort also investigates advanced signal processing and detection algorithms for increased real-time feedback for threat detection and identification, and it collects data to inform studies investigating methods to reduce the operator's cognitive burden. ***FY 2018 Plans:*** Finalize combinations of novel components and sensors to support real-time detection and identification of buried explosive hazard threats in relevant outdoor environments; conduct experiments to confirm component designs and mature signal processing techniques; mature visualization components to enhance clutter rejection and improve operator interfaces; conduct limited user assessment of integrated breadboard design. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** This effort is ending in FY18			
Title: Counter Explosive Hazard Phenomonology ***Description:*** This effort investigates potential long term solutions to nonconventional explosive hazard threats. It leverages recent lessons learned to investigate new ideas and emerging counter explosive hazard (CEH) technologies by gaining a better understanding of how to detect, neutralize, and mitigate the threat. The effort includes a series of innovative exploration and discovery events focused on the identification of new ideas and concepts in a structured and organized framework, enabling the Army to identify/investigate opportunities to leverage technologies traditionally associated with other arenas, such as the intelligence community, big data, and the financial industry. ***FY 2018 Plans:*** Evaluate and validate nonconventional CEH technologies for buried or concealed explosive hazard detection, such as novel neutron sources and gamma detectors for identification of buried explosive, and radio frequency (RF) atomic magnetometers for discrimination of buried man-made objects; continue the ongoing series of innovative investigation and informational events with industry and academia to collect information on previously unexplored phenomenologies. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** This effort was ended in FY18 to move funds to higher priority efforts.	2.704	2.790	-
Title: Neutralization and Breaching Technology	-	-	4.122

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602712A / *Countermine Systems*	**Project (Number/Name)** H24 / *Countermine Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: This effort addresses the challenges of selectively neutralizing individual explosive hazards at standoff ranges as well as the challenges of scaling up such capabilities to neutralize multiple explosive hazards for effective complex obstacle breaches. This effort focuses on validation of techniques to confirm the location of buried threats and on the design and development of technology components to defeat the confirmed target. The result is matured components to facilitate follow-on efforts to develop an integrated explosive hazard neutralization and breaching capability. Examples of candidate technologies for neutralization include high energy devices (lasers and radio frequency) and explosives. ***FY 2019 Plans:*** Will investigate standoff confirmation sensor techniques to determine discrimination thresholds and to set parameters for the design of neutralization techniques; will investigate laser, radio frequency, and microwave sources to determine maturity; determine options for use of explosive techniques. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** This is a new start in FY19			
Accomplishments/Planned Programs Subtotals	20.038	20.453	15.248

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602712A / *Countermine Systems*	Project (Number/Name) H35 / *Camouflage & Counter-Recon Tech*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H35: *Camouflage & Counter-Recon Tech*	-	5.457	5.737	5.996	-	5.996	6.788	6.882	7.072	7.214	0.000	45.146

A. Mission Description and Budget Item Justification

This Project investigates, designs, and develops techniques for masking friendly force capabilities and intentions. The Project pursues technologies to reduce the susceptibility of sensor systems to detection and targeting by threat forces, as well as to inform the development of next generation camouflage coatings and paints. Novel technologies are investigated, such as novel optics designs combined with signal processing, spectral filtering, and threat sensing algorithms.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Camouflage and Counter-Reconnaissance Technology for Advanced Spectral Sensors	5.457	5.737	5.996
Description: This effort investigates and advances new techniques to reduce susceptibility of sensors to detection by lasers, Electro-Optic (EO) sensor systems, and Infrared (IR) sensor systems. This effort also researches signature reduction approaches for camouflage nets.			
FY 2018 Plans: Validate through experimentation optical cross section reduction methods for day television (TV) sensors; continue to investigate sensor vulnerabilities to future laser threats; research new materials, devices, and strategies to counter these threats; develop sensor protection technologies that can be applied to new day TV sensors employed on multiple platforms. Define signature reduction characteristics for urban and artic camouflage solutions for both vehicles and dismounts.			
FY 2019 Plans: Will investigate new protective coatings for dual band IR systems that have high out of band rejection, very high in-band transmission, and laser durability while still meeting camera window environmental performance requirements; will continue to support signature characteristics testing for urban and arctic camouflage solutions for both vehicles and dismounted Soldiers.			
FY 2018 to FY 2019 Increase/Decrease Statement: Increase in FY19 funds due to inflation.			
Accomplishments/Planned Programs Subtotals	5.457	5.737	5.996

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602712A / *Countermine Systems*	**Project (Number/Name)** H35 / *Camouflage & Counter-Recon Tech*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602712A / *Countermine Systems*	Project (Number/Name) HB2 / *COUNTERMINE COMPONENT TECHNOLOGY (CA)*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
HB2: *COUNTERMINE COMPONENT TECHNOLOGY (CA)*	-	4.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	4.000

Note

Congressional increase for Program increase

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Countermine Systems applied research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Program Increase	4.000	-
FY 2017 Accomplishments: N/A		
Congressional Adds Subtotals	4.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602716A *I Human Factors Engineering Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	23.359	24.127	24.131	-	24.131	24.596	25.092	25.604	26.116	0.000	173.025
H70: *Human Fact Eng Sys Dev*	-	23.359	24.127	24.131	-	24.131	24.596	25.092	25.604	26.116	0.000	173.025

A. Mission Description and Budget Item Justification

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

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

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

Results of these efforts are transitioned to the Research, Development, and Engineering Centers, the Program Executive Offices (PEO) & Program Managers, Army Training and Doctrine Command (TRADOC), Army Medical Command (MEDCOM), Human Systems Integration (HSI) Directorate (Army G1), and Army Test and Evaluation Command (ATEC).

The cited work is consistent with the S&T priorities of the Army's Chief of Staff, Assistant Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

Work is performed by the Army Research, Development, and Engineering command (RDECOM).

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army					Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*			R-1 Program Element (Number/Name) PE 0602716A / *Human Factors Engineering Technology*		
B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	23.671	24.127	25.160	-	25.160
Current President's Budget	23.359	24.127	24.131	-	24.131
Total Adjustments	-0.312	0.000	-1.029	-	-1.029
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.308	-			
• Adjustments to Budget Years	-	-	-1.029	-	-1.029
• FFRDC	-0.004	-	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602716A / *Human Factors Engineering Technology*	Project (Number/Name) H70 / *Human Fact Eng Sys Dev*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H70: *Human Fact Eng Sys Dev*	-	23.359	24.127	24.131	-	24.131	24.596	25.092	25.604	26.116	0.000	173.025

A. Mission Description and Budget Item Justification

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

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

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

Results of these efforts are transitioned to the Research, Development, and Engineering Centers, the Program Executive Offices (PEO) & Program Managers, Army Training and Doctrine Command (TRADOC), Army Medical Command (MEDCOM), Human Systems Integration (HSI) Directorate (Army G1), and Army Test and Evaluation Command (ATEC).

The cited work is consistent with the S&T priorities of the U.S. Army Chief of Staff, Assistant Secretary of Defense for Research and Engineering priority focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Interfaces for Collaboration and Decision Making	2.695	2.756	2.847
Description: This effort looks at the study of how networks influence, and are influenced by, human behavior in the context of military decision making. The studies, which range from computational modeling to networked simulations in a laboratory environment, to large-scale simulation exercises, will investigate the effects of technology on information flow, cognitive workload, team collaboration, organizational effectiveness, situational awareness, and decision making. ***FY 2018 Plans:*** Develop metric approach to quantify digital performance in human-system interactions; leverage current networking technology and recent advances in wearables and computer-mounted sensor technologies to collect and analyze large volumes of data to characterize behavioral, physiological, task-based and environmental factors influencing task performance and decision making			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*	**Project (Number/Name)** H70 / *Human Fact Eng Sys Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
of individuals and teams; develop cyber-security ontologies and scenarios to characterize human dynamics in the cyber domain using approaches such as game theory, artificial intelligence, cognitive modeling, multi-agent simulation, and online platforms for investigation. ***FY 2019 Plans:*** Will develop initial capability for real-time empirical assessment of human cyber performance to include leveraging human digital behaviors (i.e. keystrokes, mouse-clicks, tool use, screen recordings); identify specifications for Soldier cyber security training needs in tactical environments; develop techniques and measures to assess cyber team effectiveness; create behavioral models of Soldier situation understanding and defense of enterprise-level networked operational environments; continue development of capabilities for dynamic human/agent cyber experimentation using cyber test-range for on-site and remote human-in-the-loop experiments with authoring and execution of repeatable cyber scenarios. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased investments to expand program to develop real-time assessment of human cyber performance.			
Title: Human Performance Modeling ***Description:*** Enhance human performance modeling tools to enable system analysis that will inform system design early in the acquisition process. These tools will allow the identification of design flaws that can be mitigated to reduce workload and human errors and increase user acceptance of developing technologies allowing the Soldier to extract the maximum performance from the equipment. Collect and analyze empirical data on human perception (vision and hearing) to support human and system performance models used for equipment design and training. Efforts are coordinated with Program Element (PE) 0602786A/H98 (Clothing and Equipment Technology). ***FY 2018 Plans:*** Maintain and improve IMPRINT reporting and visualization capabilities; update new performance shaping functions within IMPRINT; research trustworthiness effects within communities and develop methods of using human performance modeling tools as a hybrid modeling architecture; and enhance accommodation modeling tools with improved H-point seated posture positioning for human figure modeling analysis. ***FY 2019 Plans:*** Will investigate the use of Human Systems Integration (HSI) tools to validate the effects of autonomous systems on operator workload and mission performance; conduct human performance modeling tool maintenance, development, and support; continue to extend development of human accommodating analysis to quantify human resource costs in terms of manpower, personnel	0.974	0.506	1.080

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*	**Project (Number/Name)** H70 / *Human Fact Eng Sys Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
and training; develop training videos to support the HSI practitioners; explore the development of human agent assisted tools for supporting HSI evaluations and assessments. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased investments to expand Human System Integration program.			
Title: Brain-Computer Interaction ***Description:*** Investigate the use of neurophysiological and behavior-based technologies for enhancing the interaction between Soldiers and systems such as autonomous systems and advanced crew stations. Implement guidelines for: algorithms for characterizing Soldier brain activity in operational contexts; real-time techniques to integrate neurally-based information into systems designs. ***FY 2018 Plans:*** Develop and integrate novel neural classification algorithms that enable brain-computer interaction technologies for image analysis to be used without requiring a calibration to the individual user. ***FY 2019 Plans:*** Will develop novel multiclass rapid-serial visual presentation brain-computer interaction paradigms for improved integration with deep-learned computer vision; develop novel approaches for determining the optimal allocation of images across hybrid teams of computer vision and brain-computer interface-using humans for enhancing efficiency of image analysis. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduced investment in brain-computer interaction paradigms in order to support the development of tools for assessing human/ intelligent team performance.	2.134	3.540	1.238
Title: Dismounted Soldier Performance ***Description:*** Investigate equipment design standards and human performance measures and create guidelines for maneuver team information systems solutions that improve situational understanding and decision cycle time; identify, mature, and quantify human performance limitations to address future warrior performance issues. ***FY 2018 Plans:*** Work to understand the underlying mechanisms by which physical load (equipment mass, physical fatigue, etc.) affects dismounted Soldier performance; investigate the effects of team interaction on operationally relevant cognitive and physical tasks; work to quantify the effect of human variability on the performance of small arms shooting accuracy, and determine ways of mitigating negative effects. ***FY 2019 Plans:***	7.507	5.256	1.384

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*	**Project (Number/Name)** H70 / *Human Fact Eng Sys Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Will determine the performance thresholds associated with individual and small team performance as a function of physical and cognitive constraints; examine the distinctions between equipment configurations, including novel system interface approaches designed to improve performance metrics (e.g., timing, accuracy, mobility); continue to investigate the effects of human variability on the performance of small arms shooting accuracy, and will determine ways of mitigating negative effects; conduct studies that relate characteristics of individual Soldier weapon systems, ancillary equipment, and ammunition to dismounted Soldier shooting performance (accuracy and precision). ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decreased investments in physical load mechanisms in order to support the development of Soldier focused neurotechnologies.			
Title: Human-Robot Interaction ***Description:*** Design human-centered design requirements and technologies for supervision and Soldier interaction with multiple semi-autonomous unmanned vehicles in urban and unstructured environments. This research will be transitioned to U.S. Army Tank Automotive Research Development and Engineering Center (TARDEC). ***FY 2018 Plans:*** Refine multimodal bidirectional communications solutions, including natural language and language-based methods, for effective Soldier-agent interaction and teaming; enhance models of trust and transparency to serve as basis for human-centered design requirements for intelligent, autonomous systems; both bidirectional communications and trust and transparency will be considered in a variety of applications, including multi-human, multi ? intelligent agent, distributed systems. ***FY 2019 Plans:*** Will extend advances in multimodal, bidirectional communications models, including natural language solutions for small teams, to enhance Soldier collaborations with multiple heterogeneous agents in a distributed operational environment; enhance models of trust and transparency to include adaptive roles for both humans and agents and serve as basis for human centered design requirements in multi-agent systems; explore applications for bidirectional communication and trust and transparency to include both mounted and dismounted operations. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Expanded investments in communication models to support S&T strategy and senior leader priorities.	2.998	3.054	3.135
Title: Understanding Socio-cultural Influence ***Description:*** Investigate and model cognitive aspects of socio-cultural influences on Soldier/Commander decision making and communication to enhance Soldier performance with systems, within teams and in the mission context. Extend models of individual and teams to societal levels to support regional understanding, training, mission rehearsal, and influence. This	2.029	2.060	2.059

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*	**Project (Number/Name)** H70 / *Human Fact Eng Sys Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
work complements and is coordinated with PE 0602784A/T41 (Socio/Cultural Behavior) and PE 0602785A/790 (Personnel Performance & Training Technology). ***FY 2018 Plans:*** Validate new social cultural representation models integrating civil affairs and intelligence social-cultural expertise into the US Army?s Common Operating Picture to augment the Commander?s military decision making process; identify sociocultural influences that facilitate teaming amongst socio-cultural diverse groups; develop an ontological framework of these influences and interactions to obtain a better understanding of cause and effect and to support predictive model development. ***FY 2019 Plans:*** Will continue to quantify the processes and proficiencies that are selected for and taught by practitioners who collect, process, and distribute sociocultural information within the Army; develop a predictive model of group behavior based on religion to augment Civil Affairs decision making; conduct preliminary experiments to explore methods for improving situational understanding and decision making when visualizing sociocultural information in virtual reality; leverage theory from cognitive science to inform experimentation. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Minor reduction in the visualization of sociocultural information.			
Title: Continuous Multi-Faceted Soldier Characterization for Adaptive Technologies ***Description:*** This effort will investigate technologies that provide the foundation for future Army systems to adapt to individual Soldier?s states, behaviors, and intentions in real-time. Develop novel approaches to individualize adaptive systems through enhanced interfaces, interactions, or interventions that capitalize on prediction methods; and decrease time-to-train, augment physical, cognitive, and social performance, and improve human-network interactions. ***FY 2018 Plans:*** Develop capability for real-time performance assessment using novel techniques for aggregation, storage and access of individual specific, low-resolution, longitudinal data from a combination of behavioral, physiological and task domains. ***FY 2019 Plans:*** Will develop techniques and algorithms to collect, synchronize and integrate high resolution behavioral, physiological, environmental, and task-based sensor information with existing low-resolution multi-faceted assessment capability to enable continuous monitoring of an individual across a variety of timescales; develop capability for real-time group-based performance	1.600	2.259	1.600

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*	**Project (Number/Name)** H70 / *Human Fact Eng Sys Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
assessment incorporating multi-faceted individual metrics and social dynamics through integration of multiple, pervasive data sources. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decreased investments in performance assessments to support senior leader Soldier Lethality priorities.			
Title: Soldier Sensory Performance ***Description:*** Conduct Soldier-oriented research to understand attention and cognitive challenges of interpreting unaided and aided tactile signals, visual imagery, and auditory events in complex, dynamic battlefield environments. Results are used for enhancing sensory performance by providing the materiel development community with the knowledge necessary to effectively design systems that maximize mission effectiveness and survivability of the dismounted Soldier.	1.485	-	-
Title: Training Effectiveness Research ***Description:*** Novel technologies and their implementation in Army systems may result in demands on Soldiers that exceed their knowledge, skill, or memory capacity. When demands cannot be remediated by human systems integration, training may enable the demands to be met. This effort will identify human operator tasks in complex, intelligent, and emerging systems critical to mission employment of new technologies. The aspects (particularly knowledge and skill) of those tasks will be determined through experimentation and analysis to inform development of training and simulation technologies, fundamental research on the effectiveness of training regimes, and simultaneous task combinations that must be trained. This effort leverages research from PE 0601102A/74A (Human Engineering) and will be transitioned to PE 0603015/S29 (Next Generation Training and Simulation Systems). ***FY 2018 Plans:*** Refine research-based integration of multi-sensor data (e.g. accuracy, communications, psycho-physiological, and/or movement/location) for automated measurement of critical training outcomes; conduct research to validate training performance assessment algorithms for virtual test-bed and live training environments; refine and validate automated performance measurement capabilities for use in evaluating the effectiveness of training. ***FY 2019 Plans:*** Will conduct experiments with refined research-based integration of multi-sensor data (e.g. accuracy, communications, psycho-physiological, and/or movement/location) for automated measurement of critical training outcomes; explore and identify training effectiveness measures for collective training (mixed reality and live); explore and identify multi-sensor data for automated measurement of effective collective training outcomes. ***FY 2018 to FY 2019 Increase/Decrease Statement:***	0.937	0.932	1.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*	**Project (Number/Name)** H70 / *Human Fact Eng Sys Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Increased investments to support collective training capabilities.			
Title: Soldier System Architecture ***Description:*** Soldier performance is affected by mission demands, environment, human characteristics, equipment, and technology. System development requires considering tradeoffs among these factors and sufficient data about them on which to base analyses. This effort will identify and develop human performance measures of effectiveness (MOEs) and measures of performance (MOPs) critical to performing individual and team tasks in a mission text. Tools and techniques for analysis of these tradeoffs will also be developed. Empirical data will be mined from existing sources or collected where gaps exist to inform the interaction among factors affecting Soldier mission performance for emerging technologies. This research supports the development of the SSEA and is coordinated with PE 0602786A/H98, 0603015A/S28, PE 0603710A/Project K70, PE 0602308A/C90, PE 0602787A/869, and 0603004A/232. ***FY 2018 Plans:*** Conduct experiments on Soldier Resilience (arousal) and Effects of Stress on Soldier performance to shoot, move, and communicate. Purpose is to collect output data informing future model development and supporting SSEA scenarios at the tactical level of warfare; validate SSEA analysis methodology and proof-of-concept front-end analysis tool in a military relevant context. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort ends in FY18.	1.000	1.004	-
Title: Rapid Soldier Capability Enhancement ***Description:*** Research the relationship of augmentation agents and Soldier performance & behavior. Investigates the effects of augmentation agents (perceptual, cognitive, and/or physical), used either individually or coupled as a system of agents, on Soldier performance, resilience, and training during operationally relevant tasks. Development of guidelines and models for designing and employing augmentation agents. Implementation of guidelines will enhance augmented Soldier performance. ***FY 2018 Plans:*** Investigate augmentation applications, including timing, amplitude, and duration relative to biological and environmental signals, to understand functionality in varied and complex environments; model performance and adaptation to augmentation agents in order to predict capability enhancement; investigate individual variability and short and long term adaptation to augmentation agents; plan to investigate the extension of methods and metrics developed for single augmentation agent to the quantification of Soldier performance while using a system of augmentation agents. ***FY 2019 Plans:***	-	2.760	2.784

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*	**Project (Number/Name)** H70 / *Human Fact Eng Sys Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Will investigate augmentation applications, to understand functionality in mounted and dismounted operational environments; enhance models of performance and adaptation to facilitate more robust prediction of capability enhancement including short and long term adaptations and factors related to individual variability; enhance metrics for quantifying Soldier performance while using a system of augmentation agents in complex environments. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Slight increase in funding to refine models of performance and adaptation.			
Title: Tools for Assessing Human/Intelligent Team Performance ***Description:*** Develop tools for verifying and validating Soldier interactions and overall human-system performance of mixed Soldier-intelligent agent teams, while providing the foundation for a generalizable tool for a broad range of Human-System Integration (HSI) assessments. Focus on flexible, tailor-able analysis tools for laboratory grade, high-resolution assessment of dismount-robot interactions in complex environments. ***FY 2019 Plans:*** Will develop portable, ?plug and play? analysis toolkit that enables individualized assessment of a single human interacting with an intelligent agent in pseudo-controlled environments. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Investment supports the acceleration of Human/Intelligent agent team performance work.	-	-	1.000
Title: Explainable Intelligence Underlying Efficient Integration of Cognitive assist Agents ***Description:*** This effort will develop novel methods for joint human / intelligent agent learning and decision making to capitalize on the individual strengths of humans and intelligent agents to improve emergent group performance; and enable rapid, cooperative decision making and learning utilizing machine learning approaches. ***FY 2019 Plans:*** Will develop novel machine learning approaches for learning the optimal allocation of tasks across hybrid teams of humans and artificial intelligent agents; develop novel approaches to deep neural networks based on the underlying geometry of the data. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Investment supports the acceleration of task allocation research for hybrid teams.	-	-	2.061
Title: Soldier Focused Neurotechnologies ***Description:*** Neurotechnologies for Soldier use are limited by a lack of sufficient tools and methodologies capable of interpreting brain data in real world environments. Research will focus on the development of novel user-transparent data acquisition systems	-	-	2.343

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*	**Project (Number/Name)** H70 / *Human Fact Eng Sys Dev*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
that are comfortable and non-invasive and on the development of robust tools that account for high levels of variance and noise expected in recorded brain data in real-world environments. ***FY 2019 Plans:*** Will determine and develop efficacy of novel materials for use in advanced validation tools for mobile brain-recording hardware; develop a framework describing the relationship between computational neural data features and the performance of corresponding neural state classifiers within non-ideal, noisy environments. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Investment supports the acceleration of Soldier neurotechnology research.			
Title: Exoskeleton ***Description:*** Accelerates Soldier lethality and mobility capabilities through exoskeleton systems with improved Soldier compatibility and reduced training requirements. Advances innovative assessment and analysis techniques and metrics that inform hardware design, system control and technology use case objectives. Identifies and matures fundamental assessment protocols for transition to Army Test and Evaluation community. ***FY 2019 Plans:*** Will identify and validate initial surrogate tasks and associated performance metrics against an anticipated urban terrain scenario; identify key quantitative measures and model their relationship to performance outcomes; characterize human movement variability in performance of and transitions between component tasks and responses to perturbations within movement through complex urban environment scenario. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort supports the acceleration of exoskeleton research in support of senior leader priorities for Soldier Lethality.	-	-	1.600
Accomplishments/Planned Programs Subtotals	23.359	24.127	24.131

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602716A / *Human Factors Engineering Technology*	**Project (Number/Name)** H70 / *Human Fact Eng Sys Dev*

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army												Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602720A *I Environmental Quality Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	21.553	21.678	13.242	-	13.242	13.503	13.773	14.051	14.329	0.000	112.129
048: *Ind Oper Poll Ctrl Tec*	-	2.686	2.860	0.992	-	0.992	1.010	1.030	1.050	1.070	0.000	10.698
835: *Mil Med Environ Crit*	-	7.524	8.005	8.043	-	8.043	8.200	8.364	8.534	8.704	0.000	57.374
895: *Pollution Prevention*	-	3.340	2.473	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.813
896: *Base Fac Environ Qual*	-	8.003	8.340	4.207	-	4.207	4.293	4.379	4.467	4.555	0.000	38.244

A. Mission Description and Budget Item Justification

This Program Element (PE) investigates and evaluates enabling tools and methodologies that support the long-term sustainment of Army training and testing activities. Specific focus is on maintaining regulatory compliance while limiting future Army liability to installation operations and training, and maintaining resilient and adaptive ranges. Project 048 improves the Army's ability to comply with requirements mandated by federal, state, and local environmental/health laws and to reduce the cost of this compliance. Project 835 develops enabling technologies for advanced life cycle analysis, advanced sensing, technologies to empower rapid fielding of next generation energetics, propellants and munitions with focus on the impacts of new materiel that will enter the Army inventory within the next decade and beyond, and enable decision making based on accurate environmental conditions in sparse data environments. Project 895 focuses on reducing hazardous waste generation through process modification and control, materials recycling and substitution, and developing technologies to predict and mitigate range and maneuver constraints associated with current and emerging weapon systems, doctrine, and regulations. Project 896 investigates technologies for ecosystem vulnerability assessment, and ecosystem analysis, monitoring, modeling, and mitigation to support sustainable use of Army lands to reduce or eliminate environmental constraints to military missions, and develops environmental sensor capabilities to enable rapid collection and analysis of data for real-time environmental situational awareness.

The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering Science and Technology priority focus areas and the Army Modernization Priorities for Long Range Precision Fires and Network/C3I, and supports the Army Strategy for the Environment.

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

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army					Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*		R-1 Program Element (Number/Name) PE 0602720A / *Environmental Quality Technology*			
B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	22.151	21.678	21.818	-	21.818
Current President's Budget	21.553	21.678	13.242	-	13.242
Total Adjustments	-0.598	0.000	-8.576	-	-8.576
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.590	-			
• Adjustments to Budget Years	-	-	-8.576	-	-8.576
• FFRDC	-0.008	-	-	-	-

Change Summary Explanation

PE decrease to support Army Modernization Priorities, including robotic engineering for Next Generation Combat Vehicle, and removal of pollution prevention tasks.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602720A / *Environmental Quality Technology*	Project (Number/Name) 048 / *Ind Oper Poll Ctrl Tec*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
048: *Ind Oper Poll Ctrl Tec*	-	2.686	2.860	0.992	-	0.992	1.010	1.030	1.050	1.070	0.000	10.698

A. Mission Description and Budget Item Justification

This Project designs and develops tools and methods to enable the Army to reduce or eliminate environmental impacts both in the United States and abroad. These new and innovative technologies are essential for the effective control and reduction of military unique hazardous and non-hazardous wastes on military installations and associated with contingency operations bases worldwide. To develop the required technologies, this Project has a focus on developing sustainable environmental protection technologies that help the Army maintain environmental compliance for sources of pollution such as production facilities, facility contamination, and other waste streams; a focus on Army-unique ecosystem vulnerability assessment, and ecosystem analysis, modeling, adaptation, and mitigation technologies for installations associated with air quality and endangered species management and their impacts on training and testing missions; a focus on designing and developing technologies for deployed forces with environmentally safe, operationally enhanced, and cost effective technologies or processes to achieve maximum diversion, minimization, or volume reduction of base camp and field waste; and a focus on the impacts of new materiel that will enter the Army inventory within the next decade and beyond. The resultant technologies reduce the impact of legal and regulatory environmental restrictions on installation facilities, training and testing lands and ranges, as well as provide a means to avoid fines and facility shutdowns within the United States and reduce environmental impacts to the Warfighter abroad.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Sustainable Ranges and Lands	1.747	1.893	-
Description: This effort supports management of operations on ranges and training lands with the intent to reduce constraints and restrictions resulting from environmental regulations. Technologies are targeted toward solutions for environmental compliance and associated requirements, as well as solutions that will enhance training and testing operations.			
FY 2018 Plans: Investigate relationships and relational patterns between physical and social data in select contingency areas of concern to enable Military security planners to anticipate climate and extreme weather induced impacts to security and readiness threats. Research relational changes in environmental variability data and changes in human behavior to assess correlation with social-environmental trends and conflict trends as seen in hazard and conflict models.			
FY 2018 to FY 2019 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*	**Project (Number/Name)** 048 / *Ind Oper Poll Ctrl Tec*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Effort ends in FY18.			
Title: Adaptive & Resilient Installations	0.939	0.967	0.992
Description: This effort develops sustainable, cost efficient, and effective facilities; and provides technologies and techniques for achieving resilient and sustainable installation and base operations. ***FY 2018 Plans:*** Investigate new coatings that promote water vapor deposition and shedding coupled with current waste vapor streams/sources. Investigate closed loop water treatment process technologies to determine best candidates in Army relevant conditions for contingency bases. ***FY 2019 Plans:*** Will follow a system of systems approach to develop an integrated installation computational model which fuses data from existing systems and programs of record to capture management business processes. Business intelligence dashboards will integrate and support synthesis and reporting across business processes and at all echelons, and will fully integrate information infrastructure that presents and provides decision-ready knowledge. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase of funds due to economical adjustments.			
Accomplishments/Planned Programs Subtotals	2.686	2.860	0.992

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602720A / *Environmental Quality Technology*	Project (Number/Name) 835 / *Mil Med Environ Crit*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
835: *Mil Med Environ Crit*	-	7.524	8.005	8.043	-	8.043	8.200	8.364	8.534	8.704	0.000	57.374

A. Mission Description and Budget Item Justification

This Project investigates and develops tools and methods to enable the Army to reduce or eliminate environmental impacts both in the United States and abroad. These new and innovative technologies are essential for the effective control and reduction of military-unique hazardous and non-hazardous wastes associated with contingency operations worldwide. These new and innovative technologies empower rapid fielding of next generation energetics, propellants and munitions with focus on the impacts of new materiel that will enter the Army inventory within the next decade and beyond, and deliver the capability to shape and protect Army investments in next generation fires by delivering proactive, scientifically sound risk and environmental impact management strategies. This Project will also provide integrated knowledge of environmental factors in mission planning activities creating a unified, comprehensive and integrated battlefield landscape of future threats, opportunities and impacts to mission success in sparse data environments enabling mission planners to identify the industrial/commercial resources used as components of weapons development. These resultant technologies streamline the acquisition process, enabling rapid fielding of new materials, increase Army readiness through proactive hazard management strategies for military materials, enhance the Army's ability to improve decision-making based on accurate environmental conditions in sparse data environments, and reduce Army liabilities associated with unforeseen environmental impacts.

Work in this Project supports the Army Science and Technology (S&T) Military Engineering and Environmental Technology, Simulation and Computing Portfolio.

The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy Priorities for Long Range Precision Fires, Air Missile Defense, and Network/C3I.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Life Cycle of Military Materials in the Environment	3.460	1.200	0.203
Description: This effort provides a quantitative means to determine the environmental and human health effects resulting from exposure to existing and emerging compounds and materials produced in Army industrial, field, and battlefield operations or disposed of through past activities. Results of this research will be integrated into the life cycle analysis process.			
FY 2018 Plans: Develop a new eco-toxicity life cycle assessment framework designed to optimize the cost-benefit of environmental data collections to address pre-Milestone B environmental assessment guidelines.			
FY 2019 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*	**Project (Number/Name)** 835 / *Mil Med Environ Crit*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Will investigate environmentally-friendly signature tonedown/alteration concepts for critical assets that integrate novel materials such as organics and nanomaterials, and characterize life cycle and environmental health and safety impacts of concealment/ countermeasure technologies. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Significant reduction to mature development of components.			
Title: Advanced Materials and Nanotechnology: Environmental Effects previously called Nanotechnology-Environmental Effects ***Description:*** This effort enables the Army's ability to field advanced nano-based technologies by appropriate identification and assessment of the environmental impacts of nanomaterials. The end result of this research is the development of tools that guide and influence the design of nanomaterials based on such factors as adverse effects on human health or on the environment. ***FY 2018 Plans:*** Investigate and categorize technologies of military relevant advanced and additive materials, including nanotechnologies and additive manufacturing techniques, to discriminate high and low risk areas as relevant to Chemical Data Reporting under the Toxic Substances Control Act. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort ends in FY18.	2.905	3.062	-
Title: Risk Prediction and Decision Technologies ***Description:*** This effort enables the Army to predict and understand the fate and transport of Army-unique compounds and materials which improves the capability to detect, control, and remediate. This effort develops advanced engineering concepts utilizing advanced materials, biological processes, and nanomaterials in remediation processes. ***FY 2018 Plans:*** Develop empirical datasets of soil structure, geochemistry, and microbial community composition and function from bench and medium-scale studies to identify on-site contaminant degradation processes and limitations in arctic and subarctic climates. Investigate the most relevant metrics needed to characterize synthetic biology environmental impacts of military relevance and quantify their relative importance. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort ends in FY18.	1.159	3.743	-
Title: Rapid Risk Analysis of Fires	-	-	3.079

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*	**Project (Number/Name)** 835 / *Mil Med Environ Crit*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: Develop proactive environment, safety, and occupational health risk assessment tools to ensure rapid fielding of energetics, propellants, and munitions. ***FY 2019 Plans:*** Will develop robust procedures for the detection and quantification of carbon-based advanced materials at concentrations relevant to sustainability analysis; identify current and future trends in additive manufacturing technologies and materials of interest to the Army to evaluate environment, health, and safety impacts during development, transition, and acquisition. Proactive environment, safety, and occupational health risk assessment tools will facilitate rapid fielding of energetics propellants and munitions. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort initiates in FY19.			
Title: Intelligent Environmental Battlefield Awareness ***Description:*** Develop technologies to provide geo-environmental infrastructure and hazard awareness in urban environments to provide decision-makers with data and information for mission planning. ***FY 2019 Plans:*** Will investigate environmental forensic methodologies to provide geo-chemical resources to mission planners. Will quantify contaminant microbial degradation/transformation activity in arctic and subarctic climates as a function of soil geochemistry and environmental flux to model contaminate fate and transport prediction for intelligence preparation on the battlefield. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort Initiates in FY19.	-	-	2.094
Title: Understanding the Environment as a Threat ***Description:*** Develop predictive tools to inform engineer reconnaissance and provide environmental situational awareness for mission planning. ***FY 2019 Plans:*** Will develop predictive models of environmental impact to inform environmental situational awareness and source analysis by investigating microbial products of synthetic biology and acquire a diverse variety of synthetic constructs to conduct lab-scale microcosm experiments with known microbes to assess potential for spread/transfer of synthetic component. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort initiates in FY19.	-	-	1.765
Title: Chemical Sensing in Contested Environments	-	-	0.902

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*	**Project (Number/Name)** 835 / *Mil Med Environ Crit*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: Develop advanced environmental sensor technologies to enable rapid collection and analysis for persistent surveillance in contested areas. This project will provide significant advances in research and development of each of the component steps (improved selectivity for passive samplers, functionalization of printable adsorption components, novel signal generation techniques, sensor arrays, etc.) to enable rapid collection and analysis. ***FY 2019 Plans:*** Will develop advanced environmental sensor technologies to enable rapid collection and analysis for persistent surveillance in contested areas ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort initiates in FY19.			
Accomplishments/Planned Programs Subtotals	7.524	8.005	8.043

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602720A / *Environmental Quality Technology*	Project (Number/Name) 895 / *Pollution Prevention*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
895: *Pollution Prevention*	-	3.340	2.473	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.813

A. Mission Description and Budget Item Justification

The Project develops pollution prevention technologies required to reduce/eliminate the environmental footprint resulting from the manufacture, maintenance, use, and surveillance of Army ordnance and other weapon systems. This Project researches and develops revolutionary technologies to eliminate or significantly reduce the environmental impacts that threaten the sustainment of production and maintenance facilities, training ranges and operational areas. The Project supports the transformation of the Army by ensuring that advanced energetic materials required for high-performance munitions (gun, rocket, missile propulsion systems, and warhead explosives) are devised to meet weapons lethality/survivability stretch goals in parallel with, and in compliance to, foreseeable sustainment requirements. Specific technology thrusts include environmentally-benign explosives developed with computer modeling using Department of Defense high-performance computing resources; novel energetics that capitalize on the unique behavior of nano-scale structures; chemically engineered explosive and propellant formulations produced with minimal environmental waste, long-storage lifetime, rapid/benign environmental degradation properties, and efficient extraction and reuse; and fuses, pyrotechnics, and initiators that are free from toxic chemicals. Other focus areas include toxic metal reductions from surface finishing processes, sustainable military paints and coatings to meet evolving environmental requirements and low global warming potential alternatives for refrigerants, fire suppressants and solvents.

Work in this Project supports the Army Science and Technology Environment and Terrain Portfolio.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Pollution Prevention Technologies	3.340	2.473	-
Description: This effort develops pollution prevention technologies to reduce/eliminate the environmental footprint resulting from the manufacture, maintenance, use and surveillance of Army ordnance and other weapon systems.			
FY 2018 Plans: Optimize green synthesis methods for melt cast explosives as potential alternatives to trinitrotoluene (TNT); explore synthesis of novel high nitrogen primary explosive compounds to replace lead used in primers and detonators; develop sustainable coatings for magnesium protection and electromagnetic shielding of aircraft; conduct laboratory-scale performance testing on alternative fire suppressants with low global warming potential.			
FY 2018 to FY 2019 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*	**Project (Number/Name)** 895 / *Pollution Prevention*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Effort ends in FY18			
Accomplishments/Planned Programs Subtotals	3.340	2.473	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602720A / *Environmental Quality Technology*	Project (Number/Name) 896 / *Base Fac Environ Qual*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
896: *Base Fac Environ Qual*	-	8.003	8.340	4.207	-	4.207	4.293	4.379	4.467	4.555	0.000	38.244

A. Mission Description and Budget Item Justification

This Project designs and develops tools as well as identification and assessment methodologies for ecosystem vulnerability assessment, analysis, monitoring, modeling, and mitigation to support real-time dynamic environmental situational awareness to enable the Army to reduce or eliminate environmental constraints to military use both in the United States and abroad and how the use of those resources impacts mission support. The Project investigates, designs, and develops novel methods and missions, providing the Army with the technical capability to manage, protect, and improve the biophysical characteristics; and the computational understanding of the Battlefield environment conditions and stressors in order to provide actionable information supporting situational awareness and influencing tactical operations. Technologies within this Project enable insertion of accurate environmental data into current intelligence and planning frameworks creating an integrated picture of the battlespace for operational decision making. This project also enhances environmental reconnaissance with advanced environmental sensing technologies to enable rapid collection and analysis of environmental data providing situational awareness for mission response.

The work in this Project supports the Army Science and Technology (S&T) Military Engineering and Environmental Technology, Simulation and Computing Portfolio.

The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering Science and Technology priority focus areas and the Army Modernization Priority for Network C3I.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Sustainable Ranges and Lands	3.980	4.150	-
Description: This effort provides ecosystem vulnerability assessment, analysis, monitoring, modeling, and mitigation technologies to support sustainable use of Army facilities, training lands, firing ranges, and airspace to reduce or eliminate environmental constraints to military missions. This effort targets integrated military land-appropriate management and control technologies for selected high priority Army land management issues including Threatened and Endangered Species (TES), Species at Risk (SAR), and invasive species. This effort enables effective management of training lands by understanding the cumulative impacts of training and non-training land use activities on critical natural resources under current and potential future climate conditions.			
FY 2018 Plans: Investigate tools, algorithms, procedures and guidance to manage installation noise in real-time; develop integrated simulation tools that incorporate weather, terrain, and mission activity into forecasting models for probability of noise complaints; investigate alternative TES management strategies and supporting technologies to respond to emerging TES mitigation policies; develop methodologies for prioritizing regional-level TES management strategies to minimize training impacts due to listed species.			
FY 2018 to FY 2019 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*	**Project (Number/Name)** 896 / *Base Fac Environ Qual*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Effort ends in FY18			
Title: Military Materials in the Environment ***Description:*** This effort develops models to predict chemical behavior in simple and complex environmental media (e.g. soils, water). These models will allow for improved understanding of how compounds and materials will move, bind, and degrade when introduced into the environment. ***FY 2018 Plans:*** Validate a robust predictive model that is capable of using inherent soil characteristics to determine the potential risks associated with environmentally relevant military activities (i.e. fate and transport of contaminants). Investigate computational approaches for important physical and chemical properties of insensitive munitions compounds in water, arid, and semi-arid environments to predict their fate and effects in natural water and in arid or semi-arid soils. Generate a computational model to predict potential chemical-biological interactions at the molecular level for assessment of military compounds. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort ends in FY18.	4.023	4.190	-
Title: Rapid Risk Analysis of Fires ***Description:*** Develop proactive assessment tools to shape and protect Army investments in next generation fires by delivering science based risk and environmental impact management strategies. ***FY 2019 Plans:*** Will explore potential environmental, health and safety hazards associated with emerging chemical and material developments to counter advanced conventional threats. Standardize methods for predicting ecological hazards of military materials early in the acquisition development process enabling potential replacement chemicals and other materials. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** New start program in FY19	-	-	2.207
Title: Understanding the Environment as a Threat ***Description:*** This effort advances the state of the science associated with computational understanding of the Battlefield environment conditions and stressors in order to provide actionable information supporting situational awareness for mission planning. ***FY 2019 Plans:***	-	-	2.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602720A / *Environmental Quality Technology*	**Project (Number/Name)** 896 / *Base Fac Environ Qual*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Will investigate computational chemistry predictions of the physical and chemical properties of insensitive munitions compounds and their degradation products, to determine their fate and effects in arid and semiarid environments and to provide actionable information supporting situational awareness and influence tactical operations. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** New start program in FY19			
Accomplishments/Planned Programs Subtotals	8.003	8.340	4.207

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army												Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602782A / *Command, Control, Communications Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	36.396	33.123	55.003	-	55.003	49.895	44.840	36.143	34.826	0.000	290.226
779: *Command, Control And Platform Electronics Tech*	-	15.835	12.837	11.148	-	11.148	13.426	13.959	12.228	12.473	0.000	91.906
CY2: *Applied Defensive Cyber*	-	0.000	0.000	8.267	-	8.267	9.423	9.533	9.714	9.908	0.000	46.845
H92: *Communications Technology*	-	20.561	20.286	35.588	-	35.588	27.046	21.348	14.201	12.445	0.000	151.475

A. Mission Description and Budget Item Justification

This Program Element (PE) researches and investigates communications, mission command (MC), and electronics components, sub-components, software and protocols that provide the Army with enhanced capabilities for secure, mobile, networked communications, assured information delivery, and presentation of information that enables decision-making. Commercial technologies are continuously investigated and leveraged where possible. Project 779 researches and develops MC software, algorithms, protocols, architectures, and devices that enable management of information across the tactical and strategic battle space; provides automated cognitive reasoning and decision making aids; allows timely distribution, presentation/display and use of MC data on Army platforms; and researches alternatives to Global Positioning System (GPS) for positioning, navigation and timing. Project CY2 investigates cyber electromagnetic activities (CEMA), cyber security devices, software and techniques to harden wireless communications networks against cyber-attacks and new mobile networking protocols that afford resilience within our networks to autonomically 'fight through' and/or evade hostile cyber effects. Project H92 supports research in communications components, software, algorithms and protocols, which allow field commanders to communicate on-the-move to/from virtually any location, through a seamless, secure, self-organizing, self-healing network.

Work in this PE complements PE 0601104A (University and Industry Research Centers), PE 0602270A (Electronic Warfare Technology) , PE 0602705A (Electronics and Electronic Devices), PE 0603270A (Electronic Warfare Technology), PE 0603772A (Advanced Tactical Computer Science and Sensor Technology), and PE 0603794A (Command, Control and Communications Advanced Technology), and is coordinated with PE 0601104A (University and Industry Research Centers), PE 0602120A, (Sensors and Electronic Survivability), PE 0602783A (Computer and Software Technology), and PE 0602874A (Advanced Concepts and Simulation).

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

Work in this PE is performed by the Army Research, Development, and Engineering Command (RDECOM), Aberdeen Proving Ground, MD.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army					Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*			R-1 Program Element (Number/Name) PE 0602782A / *Command, Control, Communications Technology*		
B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	37.803	33.123	37.798	-	37.798
Current President's Budget	36.396	33.123	55.003	-	55.003
Total Adjustments	-1.407	0.000	17.205	-	17.205
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.389	-			
• Adjustments to Budget Years	-	-	17.205	-	17.205
• FFRDC	-0.018	-	-	-	-

Change Summary Explanation

Increases in this Program Element support the Army's Modernization priority for Network/ Command, Control, Communications and Intelligence (C3I).

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602782A / *Command, Control, Communications Technology*	Project (Number/Name) 779 / *Command, Control And Platform Electronics Tech*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
779: *Command, Control And Platform Electronics Tech*	-	15.835	12.837	11.148	-	11.148	13.426	13.959	12.228	12.473	0.000	91.906

A. Mission Description and Budget Item Justification

This Project researches moveable and mobile command post hardware and other components, software and algorithms that enable commanders at all echelons to have more accurate, useful, and timely information and allows them to execute mission command (MC) from anywhere on the battlefield. Emphasis is on advancements to MC computing platforms, with a specific emphasis on positioning, navigation, and timing (PNT); user/computing platform interaction and cognitive burden reduction; informed operations; and commander-centric capabilities, including using automation to augment or supply staff capabilities. This Project researches technologies that support multi-modal man-machine interaction, battle space visualization, positioning and navigation in degraded environments (poor Global Positioning System (GPS) performance), automated cognitive decision aids, real-time collaborative tactical planning tools, open system architectures, and integration concepts which contribute to more efficient expeditionary and uninterrupted operations.

The cited work is consistent with the Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Priority for Network/C3I.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Assured Positioning, Navigation, and Timing (A-PNT)	5.690	7.313	6.445
Description: This effort investigates positioning, navigation and timing sensor and sensor integration technologies to provide position, velocity, and time information to support operational and training requirements, especially in global positioning system (GPS) denied/degraded environments. This effort also designs Position, Navigation and Timing (PNT) modeling and simulation (M&S) architectures, frameworks and models. Work being accomplished under Program Element (PE) 0603772A/Project 101 complements this effort.			
FY 2018 Plans: Investigate new methods of time transfer and novel ways to reduce size, weight and power for micro autonomous pseudolites to create expendable pseudolites that minimize the risks resulting from compromised assets; conduct research on machine learning concepts applied to navigation of autonomous vehicles to improve an autonomous vehicle?s localization and movement through a complex environment over time; continue investigation through an iterative process of design, fabrication, and test for size and performance improvements to miniature inertial sensors to augment PNT in GPS denied environments; complete validation of the use of Multi Global Navigation Satellite Systems signals (signals from foreign nation navigation satellite systems) in military applications; investigate new signals of opportunity for augmenting positioning and timing solutions on the battlefield; research dismounted anti-jam (AJ) technologies, such as wearable fabric antenna systems; explore potential applications for leveraging the new M-Code GPS signal for offensive and defensive navigation warfare operations; and develop models of PNT sensors,			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*	**Project (Number/Name)** 779 / *Command, Control And Platform Electronics Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
systems, and platforms and conduct simulations of operational scenarios to support Department of Defense (DoD) analysis of the behaviors of PNT devices and the effects these sensors have on the capabilities of United States (U.S.) forces, especially under GPS challenged conditions. ***FY 2019 Plans:*** Will research and investigate new and novel GPS-independent sensors; investigate innovative ways to use exiting PNT sensors; design and develop sensor fusion algorithms; develop portable sensor fusion core, allowing for a platform-agnostic solution for navigation in GPS denied or degraded environments that can be tailored based on mission or size, weight and power (SWAP) requirements; develop interfaces for GPS independent sensors, allowing connectivity with the portable sensor fusion core; continue investigation of miniature inertial sensors to augment PNT in GPS denied environments; continue research involving LIDAR odometry, visual navigation, and map building as potential sensor packages for use with the sensor fusion core; investigate new signals of opportunity for augmenting positioning and timing solutions on the battlefield; continue to improve localization and movement of an autonomous vehicle using PNT sensors through a complex environment; and continue to develop models of PNT sensors and conduct simulations of operational scenarios, especially under GPS challenged conditions. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decrease due to completion of Science and Technology Objective program completion. The program completed the investigation of technologies for alternative navigation.			
Title: Next Generation Mission Command Technologies	10.145	5.524	4.703
Description: This effort investigates, designs and codes software to enable a uniform mission command (MC) capability and experience for the commander in the command post, on the move in vehicles, or dismounted, increases the situational awareness through software data architectures and algorithms that intelligently share data across low bandwidth networks and across dismounted, mounted and command post platforms, and improves decision making capacity across the battlefield by using software knowledge representation to model mission, enabling artificial intelligence techniques to use the model to automate staff tasks, correlate and analyze information and provide recommendations. Work being accomplished under PE 0603772A/Project 101 complements this effort. In Fiscal Year 2019, funds in this effort are realigned to support the Army science and technology (S&T) priorities as identified at the December 2016 S&T Army Requirements Oversight Council by the Chief of Staff of the Army. ***FY 2018 Plans:*** Further research, in the second of a three year effort, to develop a software model that is a knowledge representation of a mission to enable automation of tasks such as developing course of action and staff assignment recommendations; research and develop a framework with standard interfaces that allows externally developed software to communicate with the mission model and leverage the data to perform real time analytics such as continuous power predictions for the mission; research and refine business process modeling technologies to assist users with dynamic and reusable workflows that align with the military			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*	**Project (Number/Name)** 779 / *Command, Control And Platform Electronics Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
decision making process or a unit?s standard operating procedures; and complete research and investigation of several artificial intelligence techniques including machine learning and intelligent agents that will be down selected and implemented in Fiscal Year (FY) 2019 and FY 2020 to assess the mission objectives and current situation to help with situational understanding by providing visualizations of how the situation is deviating from intent with continuous running estimates and an on-going analysis of risks and opportunities. ***FY 2019 Plans:*** Will investigate and leverage relevant research and technology in pattern matching and cognitive science; develop data-driven decision tools with pre-populated decision models, user directed machine learning, and machine directed human learning to enhance the speed of decision making in high operational tempo environments; design a software framework to allow the dynamic connection of information sources and sensors to decision tools; and develop and validate visualization techniques that supply increased situational awareness, understanding, and recommendations based on the primary, secondary, and third order effects of decisions through the identification of patterns detected in available battle-space data, resulting in improved decision cycles for commanders and staff. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decrease to meet Army priority for Network/C3I.			
Accomplishments/Planned Programs Subtotals	15.835	12.837	11.148

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602782A / *Command, Control, Communications Technology*	Project (Number/Name) CY2 / *Applied Defensive Cyber*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
CY2: *Applied Defensive Cyber*	-	0.000	0.000	8.267	-	8.267	9.423	9.533	9.714	9.908	0.000	46.845

Note

Project funding was realigned in FY19 from Project H92, Communications Technology, to Project CY2, Applied Defensive Cyber. Funding was realigned in accordance with Volume 2B, Chapter 18, of the DoD Financial Management Regulation (FMR), requiring all "cyberspace activities" funding move into pure budget Projects.

A. Mission Description and Budget Item Justification

This Project investigates cyber electromagnetic activities (CEMA), cyber security devices, software and techniques to harden wireless communications networks against cyber-attacks and new mobile networking protocols that afford resilience within our networks to autonomically 'fight through' and/or evade hostile cyber effects. This Project also investigates and applies robust cyber security techniques and applications to advanced communications and networking devices, software, algorithms and protocols utilized within wireless tactical networks to protect against nation state level cyber effects and maintain Warfighter confidence in network information, resources, identities and mission partners by hardening the blue force attack surface.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Defensive Cyber Operations	-	-	6.588
Description: This effort investigates and applies robust cyber security techniques and applications to advanced communications and networking devices, software, algorithms and protocols utilized within wireless tactical networks to protect against nation state level cyber effects and maintain Warfighter confidence in network information, resources, identities and mission partners by hardening the blue force attack surface. These capabilities will harden the attack surface by ensuring trustworthy software (SW), hardware (HW), information systems, communications and networks. This effort affords resilience within our networks to autonomically ?fight through? and/or evade hostile cyber effects and provide situational understanding (SU) to enable effective mission planning and execution. Work being accomplished under 0602782A/Project H92 and 0603794A/Project EL5 complements this effort, and this effort is fully coordinated with the Army Research Lab Cyber Security Collaborative Research Alliance, 0601104A/Project EA6. In FY19 this effort was moved from Project H92 per an Office of the Secretary of Defense directive to identify cyber investments in cyber unique Projects.			
FY 2019 Plans: Will research and validate cyber security technologies to improve the depiction, perception, and understanding of cyber space as it pertains to a commander?s operational environment to speed actionable decisions; will research cyber hardening methodologies for software, hardware, identities, and information to create trusted architectures and measures of provable			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*	**Project (Number/Name)** CY2 / *Applied Defensive Cyber*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
identity, pedigree, and provenance; will investigate robust built-in techniques that enable systems and networks to absorb, fight through, and adapt to adversary attacks; will research and design autonomic techniques, models and algorithms to support convergence of defensive cyber, offensive cyber, EW, and network/spectrum management information to improve decision response; will research and validate block-chaining methodologies to trace and validate pedigree of tactical information as it traverses the network; will research and validate robust non-intrusive identity authentication techniques that supports tactical access control; and will research models and algorithms that can provably determine a confidence factor associated with software vulnerability prioritization. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** New Cyber project created in FY19 per an Office of the Secretary of Defense directive to identify cyber investments in cyber unique Projects.			
Title: Cyber Collaborative Research Alliance (CRA) ***Description:*** This effort will take innovative basic research theories from the Cyber Collaborative Research Alliance (CRA) and experimentally validate the hypothesis and create proof-of-concept defensive cyber software implementations. Work being accomplished under 0602782A/Project H92 complements this effort, and this effort is fully coordinated with the Army Research Lab Cyber Security Collaborative Research Alliance, 0601104A/Project EA6. In FY19 this effort was moved from Project H92 per an Office of the Secretary of Defense directive to identify cyber investments in cyber unique Projects. ***FY 2019 Plans:*** Will investigate and validate artificial intelligence and machine learning models and methods for reasoning on real time vulnerability prediction/analysis at a system-of-system perspective; will investigate use of modeling methodologies and techniques to capture and specify system properties (e.g., structural and behavioral), and will characterize cybersecurity attributes (e.g., confidentiality, integrity and availability); will investigate biological-inspired self-securing models and methods that can support capabilities to autonomously perform analytic monitoring, maintain dynamic representation, realign their resources as necessary, and be able to substantiate integrity; and will investigate models and methods that can estimate what likely impact a vulnerability will cause to a system or network based on incomplete and inaccurate data. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** New Cyber project created In FY19 per an Office of the Secretary of Defense directive to identify cyber investments in cyber unique Projects.	-	-	1.679
Accomplishments/Planned Programs Subtotals	-	-	8.267

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*	**Project (Number/Name)** CY2 / *Applied Defensive Cyber*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602782A / *Command, Control, Communications Technology*	Project (Number/Name) H92 / *Communications Technology*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H92: *Communications Technology*	-	20.561	20.286	35.588	-	35.588	27.046	21.348	14.201	12.445	0.000	151.475

Note

Project funding was realigned in FY19 from Project H92, Communications Technology, to Project CY2, Applied Defensive Cyber. Funding was realigned in accordance with Volume 2B, Chapter 18, of the Department of Defense Financial Management Regulation (FMR), requiring all "cyberspace activities" funding move into pure budget Projects.

A. Mission Description and Budget Item Justification

This Project investigates and applies advanced communications and network devices, software, algorithms and services by leveraging and adapting commercial research and new communications and network sciences work by the Army Research Lab, Network Science Collaborative Technology Alliance or other Basic Research efforts. This Project leverages developments in wireless transport (e.g. mobile radio based communications systems) to design new techniques for improving communications in high radio frequency (RF) interference environments, such as in the presence of electronic warfare (EW), and to increase the communications capacity of terrestrial and satellite communications (SATCOM) systems. This Project also investigates antenna components, materials, designs and configurations to reduce the visual signature of antennas on Soldier, vehicular and airborne platforms and to reduce co-site interference on platforms with multiple transceivers, such as radios and jammers. Additionally, this Project investigates defensive cyber, cyber security devices, software and techniques to harden wireless communications networks against cyber attacks and new mobile networking protocols to make wireless, on-the-move (OTM) communications networks more responsive to user needs. Beginning in FY19 cyber efforts are being reported in Project CY2. This Project also investigates software and techniques that improve the ability of the Soldier to manage and maintain complex, dynamic networks; and it designs spectrum management software tools to make more efficient use of the congested RF spectrum. This Project also designs new technology and techniques to lower the size, weight, power and cost of networking systems deployed on Army platforms.

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Antenna and Hardware Technologies	3.293	-	-
Description: This effort investigates low cost, power efficient, conformal and directional antenna technologies for terrestrial, airborne, and tactical satellite communications (SATCOM) ground terminals to enable them to operate on-the-move (OTM) over multiple frequency bands, and it further investigates armor embedded antenna and distributed array technologies. Together these efforts will improve ground forces electronic protection, increase signal power and range and provide greater connectivity for both mounted and dismounted forces. Work being accomplished under Program Element (PE) 0602270A/project 906, PE 0603270A/ project K15 and PE 0603794A/Project EL4 complements this effort.			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*	**Project (Number/Name)** H92 / *Communications Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Communications, Adaptive Networks to Improve Maneuver Operations, formerly Networking to Improve Maneuver and Expeditionary Operations	-	4.508	15.205

Description: This effort investigates new capabilities to provide a range of robust, reliable, scalable, agile, interoperable and resource efficient communications capabilities to forces on the move. These capabilities allow forces to conduct maneuver operations, develop situational understanding, and sustain operations while maintaining freedom of movement.

FY 2018 Plans:
Research, brassboard, and conduct laboratory experiments on new short range wireless transmission technologies to improve performance and robustness of secure wireless personal area networks for on-Soldier sensors and ancillary devices; conduct studies, simulations, laboratory experiments and provide incremental enhancements to commercial wireless technologies, such as cellular Long Term Evolution (LTE), to adapt them for use in the tactical environment as a low cost and rapidly adaptive capability to the warfighter; conduct research, simulations and lab experiments for next generation terrestrial and SATCOM radios and code waveform protocols to conduct reliable communications in austere environments; conduct analysis, simulations and lab experiments to design and code networking protocols for network relays to be carried by autonomous systems and to optimize networking capabilities resulting from autonomous maneuvering of these relays on the battlefield; and conduct research, simulations and lab experiments to minimize the burden of network configurations and to visualize, gather information from and control all networked devices in the battlefield.

FY 2019 Plans:
Will design and develop exquisite local communication techniques with inherent low probability of interception/low probability of detection (LPI/LPD) characteristics and high frequency reuse for spectrum supportability; investigate use of non-traditional networking methods for high bandwidth needs; design and develop techniques to extend the range of waveforms with propagation limitations and challenges operating through obstruction blockages (e.g. foliage, building, etc.) for line of sight networking; investigate technology with large channel bandwidths that support high data-rate transfer; design and develop mature non-traditional transceiver components for increased capacity, and reduced interference; conduct experiments for high bandwidth, resilient communications for high data rate applications, with improved communications protection between nearby vehicles with LPI/LPD; investigate improved methods to adapt LPI/LPD techniques to mesh networks to counter contested threats in the spectrum environment; mature distributed dismounted beam forming algorithms that enable two distributed beam forming nets to communicate; design and develop an architecture, and related protocols, for secure connection onto existing or third party transport infrastructure; investigate methods to utilize existing networks that will increase available network bandwidth and provide access to resources through a local network topology in which infrastructure nodes cooperatively connect directly, dynamically, and non-hierarchically; begin the design and development of a system that integrates sensor data which is harvested from existing fielded receivers, and propagated across the network to enable improved situational understanding; design and develop components that will help incorporate future radio systems into the sensing architecture; develop data analytics

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*	**Project (Number/Name)** H92 / *Communications Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
algorithms to identify, evaluate, and correlate specific events from available tactical and intelligence data, leveraging standard protocols and interfaces to current and future tactical receivers with associated visualization and data analytics tools; investigate components for low cost, unattended sensors that can be readily distributed ,then discarded, within an area of interest; develop interfaces and methods to use existing tactical radios and receivers; develop small, easily dispersible sensors to deliver large scale sensing over designated areas; develop data consolidation and sampling methods to minimize bandwidth use of large scale sensing devices available through tasking existing receivers. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase to meet Army priority for Network/C3I, including non-traditional waveform development , technologies for communications and mission command over non-tactical network infrastructures, and research development of components for low cost, dispersible unattended sensors that can be utilized to gain and maintain situational awareness of the status of the tactical network.			
Title: Tactical Information Assurance (IA) and Cyber Defense ***Description:*** This effort investigates, codes and fabricates software, algorithms and devices to protect wireless tactical networks against computer network attacks. Effort includes technologies that are proactive rather than reactive in countering attacks against tactical military networks. Work being accomplished 0603794A/Project EL5 complements this effort, and is fully coordinated with the Army Research Lab Cyber Security Collaborative Research Alliance, PE 0601104A/Project EA6.	6.396	-	-
Title: Communications Security ***Description:*** This effort researches technologies to improve the security posture of wired and wireless communications components, software and algorithms. Work being accomplished under 0603794A/ Project EL5 complements this effort.	3.717	-	-
Title: Defensive Cyber Operations, formerly Cyber/CEMA Operations ***Description:*** This effort investigates and applies robust cyber security techniques and applications to advanced communications and networking devices, software, algorithms and protocols utilized within wireless tactical networks to protect against nation state level cyber effects and maintain Warfighter confidence in network information, resources, identities and mission partners by hardening the blue force attack surface. These capabilities will harden the attack surface by ensuring trustworthy software (SW), hardware (HW), information systems, communications and networks. This effort affords resilience within our networks to autonomically ?fight through? and/or evade hostile cyber effects and provide situational understanding (SU) to enable effective mission planning and execution. Work being accomplished under 0602872A/Project CY2 and 0603794A/Project EL5 complements this effort, and this effort is fully coordinated with the Army Research Lab Cyber Security Collaborative Research Alliance, PE 0601104A/Project EA6. In FY19 this effort was moved to Project CY2 per an Office of the Secretary of Defense directive to identify cyber investments in cyber unique Projects.	-	7.596	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*	**Project (Number/Name)** H92 / *Communications Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2018 Plans: Research and design cyber security technologies to improve situational awareness (SA) and SU of cyber threat correlated to mission impact across Cyberspace Electromagnetic Activities (CEMA) elements to enable actionable decisions, and enable self-defending qualities within Army networks that can absorb, deflect, evade, and deceive adversarial cyber actions; research and conduct experiments on robust wearable 2 factor (i.e., token plus personal identification number) identity and network access capabilities to improve identity verification and authentication processes; research and develop anomalous behavior and insider threat detection techniques to apply to tactical radio waveforms to improve communications security against cyber threats; research and experiment with mechanisms to track data flows, monitor data modification, and ensure trusted pedigree of the information flowing across tactical networks; develop models and algorithms to reason on cyber adversary intent and predict next action; research and code intelligent algorithms to efficiently pin point potentially exploitable areas within software; design and code models and techniques utilizing a software defined networking architecture to improve tactical network resilience; design and code spectrum awareness models and algorithms to detect denied spectrum conditions from jamming or other interference; and design a security architecture that supports convergence across the intelligence, network operations, cyber, EW, Fires, and information operations functions within a tactical Command Post. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** In FY19 this effort was moved to Project CY2 per an Office of the Secretary of Defense directive to identify cyber investments in cyber unique Projects.			
Title: Cyber Collaborative Research Alliance (CRA)	-	2.916	-
Description: This effort will take innovative basic research theories from the Cyber CRA and experimentally validate the hypothesis and create proof-of-concept defensive cyber software implementations. Work being accomplished under 0602872A/ Project CY2 complements this effort, and this effort is fully coordinated with the Army Research Lab Cyber Security Collaborative Research Alliance, PE 0601104A/Project EA6. In FY19 this effort was moved to Project CY2 per an Office of the Secretary of Defense directive to identify cyber investments in cyber unique Projects. ***FY 2018 Plans:*** Validate new defensive cyber theories in stealthy virtual machine migration, advanced persistent threat detection, malware communication detection, port scanning attack detection, and evidence collection for cyber-attacks; design models and algorithms in support of computer network defense and counter attack technologies; develop software to address cyber risk, detection, agility, and human psychosocial elements as they relate to cyber defense; develop and validate new defensive cyber metrics; run defensive cyber operation experiments to assess tactical applicability of new cyber theories/models; make determinations on how new validated cyber theories impact other on-going cyber research and how those programs should shift their technical			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602782A / *Command, Control, Communications Technology*	**Project (Number/Name)** H92 / *Communications Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
implementations; and mature cyber theories into software capabilities that can transition into ongoing and future Cyber/CEMA Operations programs of record. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** In FY19 this effort was moved to Project CY2 per an Office of the Secretary of Defense directive to identify cyber investments in cyber unique Projects.			
Title: Future Communications and Networking Technologies ***Description:*** This effort investigates and fabricates components and codes software for radios and network management systems to enable access to spectrum that is unavailable because of current inefficient spectrum management methods. This includes new management and visualization modalities as well as improved RF modulation techniques, devices and software. This effort investigates technologies for networking protocol development as well as networking technologies for routing and disruption tolerant networks. This effort also investigates RF signal processing, signal transmission and codes software to detect and overcome the interference of SATCOM due to jamming or atmospheric conditions. Work being accomplished under 0603794A/ Project EL4 complements this effort.	7.155	-	-
Title: Communications, Robust Tactical Systems, formerly Uninterrupted Communications ***Description:*** This effort designs and matures components, software and algorithms that enable Army tactical wireless networks to provide assured uninterrupted access to critical communications and information links so that they operate more robustly in congested, contested and competitive electromagnetic environments. These capabilities will result in robust, reliable and secure terrestrial and SATCOM networks with greater survivability in austere, congested and hostile electromagnetic environments while ensuring that the capabilities are interoperable and resource efficient and will allow forces to develop SU and conduct operations to support mission command networks even under adverse operational conditions. Work accomplished under PE 0603794A/ Project EL4 complements this effort. ***FY 2018 Plans:*** Conduct studies, simulations and laboratory experiments to mature low-cost integrated directional networking (DN) capability to enable operation in Global Positioning System (GPS)-denied environments; construct DN algorithms to implement adaptive antenna nulling techniques to direct emissions only in the desired direction for robust and undetectable communications while maintaining a robust tactical networking capability; conduct studies, simulations and laboratory experiments to develop efficient techniques to maintain capacity across multiple networks while providing low probability of interception (LPI) and low probability of detection (LPD) capability for individual users; and leverage techniques resulting from earlier efforts to make blue force electronic	-	5.266	15.583

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
warfare (EW) and communications more interoperable and provide spectrum situational awareness (SA) in real time to develop techniques for improved LPI/LPD while maintaining robust tactical communications. ***FY 2019 Plans:*** Will design and develop an agile network architecture that globally manages traffic from traditional and non-traditional networks; design and develop algorithms and software to enable resilient controls to support network traffic over Commercial and Government satellite communications (SATCOM) systems; conduct experiments to develop methods for robust narrowband SATCOM with resilience against adversary jamming; research to resilient Mission Command designs that are transport agnostic; investigate and design software-based algorithms for anti-jam, Low Probability of Interception and Deception (LPI/LPD) high frequency communications that incorporate state of the art protection against threat systems and enable operation in a contested environment of High Frequency systems; design and develop a standard interface specification to enable tactical Army units to interoperate with Navy and Air Force components; investigate components for a reliable, long range, and low data rate communications link to provide uninterrupted communications in a contested environment for the Army Tactical network; design a proof of concept adaptive system that supports multiple simultaneous radio frequency connections, multiple types of interference cancellation, incorporating diverse paths and waveforms, beam forming, and power control; design and develop a control modem supporting required connectivity, throughput, and protection to support resiliency functions in a contested environment; design and develop a software based adaptive system that supports multiple types of Wideband SATCOM interference mitigation techniques; validate applicability of cognitive reasoning software to recognize interference signals and select the appropriate mitigation techniques and, through machine-learning, grow in responsiveness; conduct experiments to evaluate uninterrupted SATCOM configurations; conduct analysis to determine approach for developing and adding interference cancellation to the Army tactical modems; design and develop algorithms for improved interference rejection and improved jammer stand-off distance to address the tactical Army threats; investigate and design a decoy signal generator of multiple waveforms, capable of deceiving Intelligence, Surveillance, & Reconnaissance (ISR) systems; design and develop obfuscator hardware, supporting sensor and policy-based dynamic spectrum access (DSA) and transmitting obfuscation (flooding)waveforms, and frequency obfuscation to hide troop?s radio frequency signatures and spend enemy resources; conduct research to enable extended reach back, data link, and localized communications for long range precision fires; design and develop a single, autonomous and intelligent network across the tactical Army, providing a common user interface and drawing on the available resilient links to maintain data flow; develop solutions to provide reliable voice/data links for the next generation combat vehicles, and tele-operation and data links for Manned/Unmanned-Teaming (MUM-T); develop components to improve resilience of Air-to-Air and Air-to-Ground links for future vertical lift and next generation unmanned aerial system; design algorithms for intelligent networks to enable resilient links and data flow capability for Fire control, sensor data flow, and proximity/distance networking for air and missile defense; validate network-enabled mission command to the dismount soldier through intelligence and situational understanding-based routing of data over resilient communication links. ***FY 2018 to FY 2019 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Increase to meet Army priority for Network/C3I, including beyond line-of-site communications, next generation HF, spectral obfuscation and protected SATCOM. Efforts will include the design and development of an agile network architecture, controls to support network traffic over Commercial and Government satellite communications systems, and a control modem supporting required connectivity, throughput, and protection to support resiliency functions in a contested environment.			
Title: Modular Radio Frequency (RF) ***Description:*** This effort enables connectivity in contested & congested environments by applying automated networking techniques to modular radio frequency (RF) technology & networking techniques to adapt and continue operation under interference signals. This is a new effort, beginning in FY 2019. ***FY 2019 Plans:*** Will design and develop product architectures based on a Modular Open System Architecture (MOSA) approach that incorporates components of network technologies into a unified solution; identify, validate, and develop standards for major internal interfaces and all external interfaces to product components and network capabilities and services; identify, develop, and validate quality attribute requirements that reflect a focus on resilience for autonomous networking to addresses critical product qualities that span a design space of feasible solutions that will allow high value services to maintain persistent network connectivity in congested and contested environments; investigate alternative requirement allocations for different network technology components that will incorporate identified technologies currently in use, and new network technologies, within an agile and resilient autonomous network; develop alternative solutions and validate selection criteria for autonomous networking approaches that provide agile detection and switching among available network connections in order to sustain the network in dense and hostile spectrum environments; investigate situation-adaptive communications to inform networks of current spectrum environment changes (e.g. interference, congestion) for the tactical network links, in an effort to optimize their performance based on available resiliency features, to implement mitigation techniques to maintain operation and inform the automated network of their status and any degradations; investigate the methods for agile networking algorithms to detect network technologies available for inclusion in the automated network processing and determine techniques to minimize user input to establish the detections, authentications, and incorporation of the technologies into the automation. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** This is a new effort, beginning in FY 2019.	-	-	4.800
Accomplishments/Planned Programs Subtotals	20.561	20.286	35.588

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
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C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602783A *I Computer and Software Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	13.452	14.041	14.958	-	14.958	15.235	15.521	15.822	16.138	0.000	105.167
Y10: *Computer/Info Sci Tech*	-	13.452	14.041	14.958	-	14.958	15.235	15.521	15.822	16.138	0.000	105.167

A. Mission Description and Budget Item Justification

This Program Element (PE) develops and characterizes information and communications processing software that automates the delivery of information used in planning, rehearsal, and execution by ground commanders. Efforts develop communication/network architectures, software, and the information fusion software necessary to simplify the understanding and interactions from humans to humans, humans to computers, and computers to humans. Research enables enhanced understanding of many information sources and accelerates the decision cycle time for commanders and leaders operating in the mobile, dispersed, highly networked environment envisioned for the future force.

Work in this PE is fully coordinated with PE 0603008A (Command, Control, Communications Advanced Technology), PE 0603772A (Advanced Tactical Computer Science and Sensor Technology), PE 0603008A (Command, Control, Communications Advanced Technology), and PE 0603794A (Command, Control and Communications Advanced Technology).

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

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

Work in this PE is performed by the Army Research Development and Engineering Command (RDECOM)

B. Program Change Summary ($ in Millions)	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**
Previous President's Budget	13.811	14.041	10.074	-	10.074
Current President's Budget	13.452	14.041	14.958	-	14.958
Total Adjustments	-0.359	0.000	4.884	-	4.884
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.354	-			
• Adjustments to Budget Years	-	-	4.884	-	4.884

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army				Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*		R-1 Program Element (Number/Name) PE 0602783A *I Computer and Software Technology*		

• FFRDC	-0.005	-	-	-	-

Change Summary Explanation

In FY 2019, this effort was increased from realigned funds to support the Army science and technology (S&T) priorities as identified at the December 2016 S&T Army Requirements Oversight Council by the Chief of Staff of the Army to support artificial intelligence.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602783A / *Computer and Software Technology*	Project (Number/Name) Y10 / *Computer/Info Sci Tech*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
Y10: *Computer/Info Sci Tech*	-	13.452	14.041	14.958	-	14.958	15.235	15.521	15.822	16.138	0.000	105.167

A. Mission Description and Budget Item Justification

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

Work in this Project is fully coordinated with Program Element (PE) 0603008A (Command, Control, Communications Advanced Technology), PE 0603772A (Advanced Tactical Computer Science and Sensor Technology), PE 0603008A (Command, Control, Communications Advanced Technology), and PE 0603794A (Command, Control and Communications Advanced Technology).

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Multi-Media Information Processing and Exploration	1.762	1.888	1.906
Description: This effort develops and characterizes fusion software to improve the completeness and timeliness of decision-making for Mission Command. The goal of this effort is to develop software applicable to the Distributed Common Ground Station ? Army (DCGS-A) architecture (an integrated architecture of all ground/surface systems) and for next generation analytic capabilities.			
FY 2018 Plans: Design and develop methods to extract information from multi-source data, predict adversarial intent, and provide indications and warnings of adversarial action for use in intelligence analysis and tactical operations; investigate collective-intelligence techniques to enhance Soldier understanding of political, military, economic and social conditions in tactical environments.			
FY 2019 Plans: Will investigate theoretically grounded approaches for uncertainty quantification and propagation in multi-scale, multi-source data and models; will develop methods for computational learning and reasoning that operate on shorter time scales and/or where			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602783A / *Computer and Software Technology*	**Project (Number/Name)** Y10 / *Computer/Info Sci Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
there may be few or no guarantees of convergence and are amenable to adaptive learning and optimization; and will develop self-organizing, self-managing, self-adapting, self-maintaining, self-protecting properties in heterogeneous complex-systems that facilitate interoperability, just-in-time human interactions, and the implementation of local-adaptation functionality in self-organizing, complex human and agent systems. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Slight increase to support evaluation of multi-scale, multi-source data and models			
Title: Cyber Security & Information Assurance ***Description:*** This effort designs and characterizes software for the protection of information and networks in wireless tactical environments. The goal is to develop software algorithms that detect and defeat malicious activities of adversaries in bandwidth-constrained tactical networks. ***FY 2018 Plans:*** Investigate and develop network-based trust models and metrics for the control and evolution of network behavior to enable more secure tactical networks and prevent adversarial disruption; explore and implement techniques for providing covert authentication of wireless communications links at the physical layer. Explore the capacity of Extremely Lightweight Intrusion Detection system-constructed weight vectors with respect to the number of signatures they can contain. Create intelligent agents that reflect actual behaviors and model them on a test-bed for human-in-the-loop experimentation, and create methods to disrupt and degrade the effectiveness of adversaries operating within a computer network. ***FY 2019 Plans:*** Will explore and implement network and physical layer based approaches for evolving network behavior to improve network resilience in the presence of adversarial disruption based on mission and information requirements; will investigate methods for machine learning (ML) with incomplete information and ambiguous guidance and applications to detect and thwart adversarial ML; will investigate generation after next applications for intrusion detection and active defense; investigate applications in threat intelligence as well as attribution of malicious code; will investigate identification of malicious activity via network sessions attributes; and will investigate techniques to secure cyber physical systems that do not have integrated security built-in. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased investments in cyber security to improve network resilience	3.873	4.050	4.925
Title: Context-Based Information Exchange ***Description:*** This effort investigates techniques that integrate local and external information sources, and it applies text and video analytic approaches to support automated intelligence analysis and decision making.	2.216	2.334	2.342

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602783A / *Computer and Software Technology*	**Project (Number/Name)** Y10 / *Computer/Info Sci Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2018 Plans: Extend user context models to incorporate continuous learning to improve performance and fit of models of individual solders over time; based on context models, investigate algorithms to foresee mission-related information requirements prior to manual requests in anticipation of soldier situational awareness gaps; develop algorithms to generate computable descriptions of location imagery captured by battlefield visual sensors. ***FY 2019 Plans:*** Will develop approaches for adversarial learning that is resilient to continuous learning threats and maximizes Soldier and agent situational awareness; will develop methods and models for complex event processing, with compact representations, efficient pattern evaluation, and mission-centric focus to accelerate reasoning and decision making; and will conduct experiments to determine methods that support diverse, nonlinear, and emergent system behaviors or tractable optimization strategies in non-stationary systems. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Slight increase to support development of approaches for adversarial learning			
Title: Multi-Lingual Computing ***Description:*** This effort develops and assesses computational multilingual algorithms and software frameworks to enable commanders and troops to bridge language barriers in order to counter adversaries and collaborate with allies. In Fiscal Year (FY) 2019, funds from this effort are realigned to support the Army science and technology (S&T) Modernization priorities. ***FY 2018 Plans:*** Develop semi-supervised analysis and deep learning methods for automated information extraction from multilingual sources; develop generalized methods for the automatic processing of document images containing multilingual handwritten and printed text; and assess human-in-the-loop methods for leveraging semantic representations of domain data to achieve high quality translations to and from low-resource languages. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** This effort was zeroed to support development of machine learning with constrained resources.	2.576	2.597	-
Title: Network Theories and Models ***Description:*** This effort investigates and designs theory based software models to characterize and validate emerging network protocols and structures. The goal of this effort is to develop software algorithms that maintain effective communications in networks in spite of disruptive effects such as task reorganization, mobility of friendly forces, and adversarial attacks on friendly networks. In FY 2019, funds from this effort are realigned to support the Army science and technology (S&T) priorities as identified	1.345	1.453	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602783A / *Computer and Software Technology*	**Project (Number/Name)** Y10 / *Computer/Info Sci Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
at the December 2016 S&T Army Requirements Oversight Council by the Chief of Staff of the Army (shifted to Machine Learning with Constrained Resources). ***FY 2018 Plans:*** Develop techniques for the distributed management & control of cognitive radio networks; implement the adaptive algorithms for robust and efficient tactical communications using cognitive and dynamic spectrum access techniques investigated and created in PE 0601102A Project H48 / Battlespace Info & Comm Rsc; and explore and implement models for influencing the evolution of communication networks in spite of mobility and adversarial attacks. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** This effort was zeroed to support development of machine learning with constrained resources			
Title: Heterogeneous Computing and Computational Sciences ***Description:*** This effort researches and develops software algorithms to allow information processing across different computing hardware platforms. The goal of this research is to provide high performance computing (HPC) / processing capabilities to the Soldier on the battlefield. ***FY 2018 Plans:*** Design algorithm development and programming methodologies to fully utilize domain-specific processor/processing architectures (custom-engineered for size, weight and power based on task); implement middleware that enables reuse of existing code to take advantage of next generation processing capabilities; and determine scalability toward exascale (billion, billion calculations per second) capability of low-power next generation processing. ***FY 2019 Plans:*** Will investigate computational capabilities and new enabling applications for domain-specific, coupled, and heterogeneous architectures; will advance computing capabilities amid fundamental limitations in exponential growth of Moore?s law via algorithmic innovations; and will develop methods to address planning, reasoning, and uncertainty at the tactical edge enhanced with heterogeneous computing resources. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Slight increase to address planning, reasoning, and uncertainty at the tactical edge enhanced with heterogeneous computing resources.	1.680	1.719	1.726
Title: Machine Learning with Constrained Resources ***Description:*** This effort will research new machine learning data sets and reinforcement learning methods to address issues of statistically mismatched and incomplete information which must be annotated, collected, classified and used for rapid decisions	-	-	4.059

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602783A / *Computer and Software Technology*	**Project (Number/Name)** Y10 / *Computer/Info Sci Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
by autonomous intelligent agent (IA) and joint IA-Human teams. In addition, multi-modal communication approaches will be investigated to ensure effective communications and understanding of intent. The goal of this research is enable joint human-intelligent agent decision making, optimizing the strengths of each in the decision process and creating an adaptive, agile team. This work applies research conducted in 61102/H48/16. In FY19, this effort was developed from realigned funds in support of the Army science and technology (S&T) priorities as identified at the December 2016 S&T Army Requirements Oversight Council by the Chief of Staff of the Army. ***FY 2019 Plans:*** Will develop methods for system-self-awareness of space, time and power characteristics and their relation to requirements of active/pending system missions, with additional ability to degrade or self-destruct gracefully; will design approaches that balance the trade-off between accuracy of computation required to answer queries of users, security concerns and mission criticality/ relevance; will investigate the use of reinforcement learning to develop resilient behaviors and learn effective strategies for accomplishing Soldier relevant mission tasks in complex environments; and will develop approaches that learn from human input develop a scalable technique for performing machine learning online, in complex Army environments, and at operational tempo. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort begins in FY19			
Accomplishments/Planned Programs Subtotals	13.452	14.041	14.958

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602784A / *Military Engineering Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	92.140	67.720	78.159	-	78.159	80.145	82.085	83.807	85.486	0.000	569.542
855: *Topographical, Image Intel & Space*	-	17.771	18.090	18.181	-	18.181	18.564	18.946	19.344	19.731	0.000	130.627
H71: *Meteorological Research For Battle Command*	-	6.470	6.628	5.676	-	5.676	5.812	5.950	6.070	6.192	0.000	42.798
T40: *Mob/Wpns Eff Tech*	-	27.827	27.955	32.567	-	32.567	33.768	34.556	35.290	35.997	0.000	227.960
T41: *Mil Facilities Eng Tec*	-	6.104	6.457	10.699	-	10.699	10.893	11.113	11.344	11.571	0.000	68.181
T42: *Terrestrial Science Applied Research*	-	5.693	5.120	5.127	-	5.127	5.232	5.371	5.483	5.593	0.000	37.619
T45: *Energy Tec Apl Mil Fac*	-	5.275	3.470	5.909	-	5.909	5.876	6.149	6.276	6.402	0.000	39.357
T53: *Military Engineering Applied Research (CA)*	-	23.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	23.000

A. Mission Description and Budget Item Justification

This Program Element (PE) investigates and advances technologies, techniques, and tools for representation of the physical and human environment for use in military planning and operations; for characterizing geospatial, atmospheric, and weather conditions and impacts on systems and military missions; for conducting mobility, counter-mobility, survivability, and force protection planning and operations; and for enabling secure, sustainable, energy efficient facilities. Research focuses on special requirements for battlefield visualization, tactical decision aids, weather intelligence products, and capabilities to exploit space assets. Project 855 conducts geospatial research and development supporting a standard sharable geospatial foundation enabling a common operating environment across mission and command systems. Project H71 supports the materiel development, testing, and operations communities in evaluating the impacts of weather and atmospheric obscurants on military materiel and operations. Project T40 advances force protection technologies across the range of military operations, including expedient protection and hardened construction to defeat complex threats. This Project also designs and develops software and hardware to identify and mitigate ground obstacles for manned and unmanned vehicles; characterizes austere navigation environments, including complex urban environments, and designs and develops materiel solutions, including rapidly emplaced bridging and expedient repair technologies, to allow austere port and airfield entry of forces; and builds and uses modeling and simulation tools to advance understanding of the interactions of weapons/munitions and novel defeat methodologies with protective construction and critical infrastructure. Project T41 investigates application of technologies to enable garrison/post commanders to plan, monitor, and operate facilities more efficiently, cost-effectively, securely, and sustainably; creates tools (including advanced models and simulations) that provide a framework for making trades and decisions; and supports research to assess non-combat population characteristics and status from social and cultural perspectives to achieve mission objectives. Project T42 develops and validates models and simulations to understand the impacts of the physical environment on the performance of forces, ground and air vehicles, and sensors; as well as the impact of natural and man-made changes in the environment on military operations. Project T45 investigates materials, components, and systems that have potential to reduce energy

losses in buildings and shelters; and potential to detect and mitigate consequences of contaminants, such as bacteria and molds, in air handling equipment and building materials.

The cited work is consistent with the Assistant Secretary of Defense, Research Engineering Science and Technology priority focus areas and the Army Modernization Strategy. The Ground Portfolio technology investments are enabling Power Projection.

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

Work in this PE is performed by the Army Engineer Research and Development Center (ERDC) and the Army Research, Development and Engineering Command (RDECOM).

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	67.416	67.720	72.097	-	72.097
Current President's Budget	92.140	67.720	78.159	-	78.159
Total Adjustments	24.724	0.000	6.062	-	6.062
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	23.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	2.500	-			
• SBIR/STTR Transfer	-0.767	-			
• Adjustments to Budget Years	-	-	6.062	-	6.062
• FFRDC	-0.009	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: T53: *Military Engineering Applied Research (CA)*		
Congressional Add: *Program Increase*	23.000	-
Congressional Add Subtotals for Project: T53	23.000	-
Congressional Add Totals for all Projects	23.000	-

Change Summary Explanation

FY17 Congressional increase of $23M in T53 Military Engineering Applied Research.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / *Military Engineering Technology*	Project (Number/Name) 855 / *Topographical, Image Intel & Space*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
855: *Topographical, Image Intel & Space*	-	17.771	18.090	18.181	-	18.181	18.564	18.946	19.344	19.731	0.000	130.627

A. Mission Description and Budget Item Justification

This Project investigates and advances capabilities for collection, processing, and creation of data and information depicting physical and human terrain, environmental conditions, and relationships in time and space; digital map creation, transmission, and dissemination; and map-based analytics for planning, decision making, and execution. This Project uses non-traditional methods that exploit existing open source text, multi-media, and cartographic materials addressing social, cultural, and economic geography to advance the capability to produce and transmit high fidelity digital maps depicting the physical terrain, human terrain, and environmental conditions. This Project also develops software tools and methods for map-based analytics that allow deeper insights into the effects of the physical terrain, human terrain, and environmental conditions on military operations, to include tactics and effects upon equipment and Soldier performance. This Project explores and advances components and methods that optimize the utility of the Army Geospatial Enterprise (AGE) to the total Army, which provides map and geospatial data, information, and software services to the total force.

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

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

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: GeoIntelligence - Geospatial Data Collection, Processing, and Decision Support (Previously titled GeoIntelligence - Geospatial Data Generation and Decision Support)	5.118	2.769	6.101
Description: This effort investigates novel map content generation and geo-temporal analytics for the development of geospatially-based decision support tools. This research focuses on automatic inference and the correlation between events and objects (i.e., people, places) through space and time from massive data sets developed in the Geoenabled Computing Environments effort. In addition, the effort investigates advanced models to forecast effects of the physical terrain, human terrain, and environment for applications to the Military Decision Making Process, an analysis that informs course of action development and evaluation of tactics, equipment, and mission risk.			
FY 2018 Plans: Investigate advanced analytical and streaming methods for geo-registering and provisioning critical infrastructure symbology to system displays supporting mounted and dismounted Warfighter situation awareness.			
FY 2019 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** 855 / *Topographical, Image Intel & Space*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Will investigate emerging computational models to increase the tempo of small unit tactical decision making through spatial reasoning, analysis, and multi-domain information and data fusion toward narrative information packages aligned with the current mission and situation. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase to meet Army priority for Network/C3I.			
Title: GeoIntelligence - Geospatial Data Analysis and Decision Support ***Description:*** This effort develops means to collect, process, and visualize very high-fidelity data and information to capture the dynamic effects of the physical and human terrain impacting military ground operations. The research focuses on tactical, rather than national or commercial, remote sensing of physical terrain to achieve the fidelity required for current and future operations. Research includes investigating new methods for effective sensor systems and materials to 'tag' features, items, and people of interest based upon novel and emerging Light Detection and Ranging (LiDAR) sensor systems, innovative LiDAR collection and analysis techniques, and an array of other sensor systems for intermittent and persistent optimal data collection, object identification, and classification for ground operations. ***FY 2018 Plans:*** Investigate new capabilities to characterize and extract (identify and map) features of interest under forest canopies such as encampments, small buildings, trails, etc. at high fidelity; develop algorithms and workflows to generate critical and accurate mapping data for units at the tactical level; and integrate frequency-modulated, continuous wave (FMCW) laser scanner into base security and defense sensor suite for 3D terrain rendition and persistent surveillance and target identification. ***FY 2019 Plans:*** Will investigate enhanced utility and quality of 3D imagery for wide area mapping and surveillance of dense urban areas; will assess utility and sufficiency of Geiger mode LiDAR prototype for wide area mapping at increasingly higher altitudes and increasing area coverage rates; and will research emerging remote sensing technologies for a multi-modal, tiered sensing approach to rapidly increase density and quality of 3D urban environment data, merging exterior, interior and below ground geospatial information. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 increase to meet Army priority for Network/C3I.	4.430	4.686	5.015
Title: Human Geography - Spatial Reasoning, Analysis, and Visualization ***Description:*** This effort investigates integration of behavior and population dynamics research and analysis into geospatial frameworks to depict the operational environment including culture, demographics, terrain, climate, and infrastructure. Research exploits existing open source text, leverages multi-media and cartographic materials, and investigates data collection methods	2.007	4.060	3.065

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** 855 / *Topographical, Image Intel & Space*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
to ingest geospatial data directly from the tactical edge to characterize parameters of social, cultural, and economic geography. Results of this research augment existing conventional geospatial datasets by providing the rich context of the human aspects of the operational environment, which offers a holistic understanding of the operational environment for the Warfighter. This item complements the work in PE 0602784A/Project T41. ***FY 2018 Plans:*** Investigate means for a repeatable methodology to incorporate social-cultural influences (e.g., civil considerations) into the military decision making process by identifying the critical conduits through which actors exercise power; and research existing authoritative data sources and potential new sources for factoring environmental and climate-related risks into long range military planning scenarios supporting theater engagement plans. ***FY 2019 Plans:*** Will develop beta model for estimating future risks and impacts of extreme weather and climate variability on water, energy and food systems to inform the Joint Preparation of the Operational Environment; and will develop critical enhancements to the suite of methods and tools supporting mission analysis for civil-military operations to enhance stability and mitigate threats to the civilian population. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY 2019 decrease due to progression of effort.			
Title: Weather and Terrain Integration ***Description:*** This effort investigates innovative methods for integrating weather and physical terrain applications with geospatial systems compliant with the Army?s Common Operating Environment approach to the Army Geospatial Enterprise thereby providing significant advancement to fused all-weather and all-season tactical decision aids supporting risk-based assessments. ***FY 2018 Plans:*** Investigate a risk-based, geospatially grounded decision support tool using multi-criteria decision analysis to facilitate a modeling environment that enables risk-informed mission decisions based on criteria including time available, physical distance, terrain or infrastructure requirement, and acceptable mission risk; and provide analytical tools that seamlessly integrate changes in the physical battlespace in near-real time with terrain based tactical decision aids, such as mounted and dismounted mobility, line of sight, and potential choke points. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort ends in FY18.	2.455	2.590	-
Title: Map-Based Planning Services (MBPS)	3.761	3.985	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** 855 / *Topographical, Image Intel & Space*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: This effort develops geospatially-enabled, collaborative mission planning capabilities providing services, data, and information to Army planners, staffs, and leaders. These mission planning capabilities will allow collecting, processing, storing, displaying, and sharing of authoritative data and information in a geo-temporal context. Work will leverage Army Geospatial Enterprise standard data sets and incorporate Geo-Enabled Mission Command tools and analytical capabilities. Resultant work products proceed into Program Element 0603734A, Project T08. ***FY 2018 Plans:*** Develop a geospatially enabled collaborative mission planning environment that provides services, authoritative data access, and information to distributed Army planners, staffs, and leaders, to enable the collection, processing, storing, displaying, and sharing of authoritative data/information in a geo-temporal context; and investigate adaptation of existing and developed intelligence preparation of the battlefield and military decision making process capabilities into the digital planning process. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort completes in FY18.			
Title: Geo-enable Computing Environments ***Description:*** This effort develops geospatially-enabled, collaborative mission planning capabilities providing services, data, and information to Army planners, staffs, and leaders. Work leverages Army geospatial enterprise standard data sets and incorporate geo-enabled mission command tools and analytical capabilities. ***FY 2019 Plans:*** Will investigate a compatible framework for sharing a relevant and focused geospatially enabled visualization of the operational environment within the command post computing environment; investigation will focus on geospatial-enabled collaborative mission planning capabilities providing services, data, and information to the Army planners, staffs, and leadership. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** New effort begins in FY19.	-	-	4.000
Accomplishments/Planned Programs Subtotals	17.771	18.090	18.181

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** 855 / *Topographical, Image Intel & Space*

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / *Military Engineering Technology*	Project (Number/Name) H71 / *Meteorological Research For Battle Command*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H71: *Meteorological Research For Battle Command*	-	6.470	6.628	5.676	-	5.676	5.812	5.950	6.070	6.192	0.000	42.798

A. Mission Description and Budget Item Justification

This Project develops tactical weather and atmospheric effects/impacts algorithms for their integration into battlefield information products. Efforts include high-resolution, local assessments and forecasts of meteorological conditions in near real time including effects of urban and mountainous terrain; analytical tools to assess the impact of the atmosphere to optimize system performance and operations planning and advanced atmospheric sensing applications to characterize and mitigate wind and turbulence in complex terrain. It provides detailed model applications for various effects of the atmosphere on electro-optical and acoustic target detection, location, and identification. This Project develops both physics-based decision aids and rule-based decision support systems for assessing the impacts of weather/ atmosphere across a spectrum of friendly and threat weapons systems, sensors, platforms, and operations. Information can be applied to mission planning and execution, battlefield visualization, reconnaissance surveillance and target acquisition, route planning to maximize stealth and efficiency, web enabled tactical decision aids, and also modeling of environmental impacts for combat simulations and war games.

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

This work transitions technologies to the Department of Defense weather and operations modeling community, the US Air Force 557th Weather Wing to improve their operational weather support to the Army Project Leader-Fire Support Command and Control and Marine Corps Systems Command (MCSC) for field artillery systems, the Project Manager, Distributed Common Ground System-Army (DCGS-A), the Joint Improvised Threat Defeat Agency, the Program Executive Office Aviation/Tactical Airspace Integration System (TAIS).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Atmospheric Characterization, Modeling, and Impacts (formerly Atmospheric Modeling)	5.120	5.622	5.676
Description: This effort develops high resolution, short-range forecasting, and high resolution atmospheric modeling capabilities for mountainous, urban, and forest complex terrain. ***FY 2018 Plans:*** Fully adapt a hybrid assimilation methodology by which meteorological data types representative of battlefield conditions may be ingested into numerical weather prediction models for enhanced forecast accuracy; demonstrate the efficacy of Geographic Information System (GIS) analytical techniques for forecast model accuracy assessments; apply intuitive, qualitative indicators of forecast confidence to meteorological data output and weather impacts displays; establish quantified performance criteria for an optical imaging system that mitigates image degradation due to atmospheric optical turbulence; enhance capabilities of route optimization tactical decision aid to minimize aircraft acoustic signatures and to account for soil type and terrain steepness			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** H71 / *Meteorological Research For Battle Command*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
affecting ground vehicle mobility and maneuver; and, implement parallel processing architectures in Personal Electronic Devices (PEDs) to allow mobile execution of weather forecast models; develop initial forward-deployed capability to integrate atmospheric prediction/weather decision aid applications into unified environmental awareness system supporting robotics and autonomous systems; and refine atmospheric acoustic signal propagation models with data collected at the MSA. ***FY 2019 Plans:*** Will research and develop decision support technology, including characterizing atmospheric impacts on and optimized paths for hypersonic munitions; will research and develop enhancements to automated routing capabilities to include accounting for acoustic signatures of air/ground platforms in varying environments (e.g. complex terrain and dense urban environments); will develop and implement methods for decision support tools to ingest and represent probabilistic components and forecast certainty/uncertainty of atmospheric prediction models; will develop a densely-instrumented urban environmental testbed with the MSA to characterize urban flow processes under varied background meteorological conditions; develop system for optimizing Weather Running Estimate-Nowcast (WRE-N) configuration based on geographical characteristics including system verification and validation; will optimize the atmospheric boundary layer environment using Lattice Boltzman method (ABLE-LBM) dynamical core for use on small platforms with accelerator cards; will demonstrate capability of incorporating unmanned aerial systems (UAS) and other local data sources into a networked- constrained Nowcast model; will develop tailored model for improved autonomous system performance; will refine of next generation atmospheric acoustic decision support tool used to determine the detection footprint of small UAS by investigating physics constrained machine learning ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Slight increase to advance modeling capability.			
Title: Local Area Atmospheric Prediction for Geospatial Applications (formerly Atmospheric Prediction for Local Areas)	1.350	1.006	-
Description: This effort designs and determines software models and sensors to improve local characterization and prediction of atmospheric conditions in urban and complex terrain by directly integrating atmospheric boundary layer (the lowest part of the atmosphere in contact with the surface) meteorological measurements into high resolution models and decision aids and validates these improvements with field measurements. ***FY 2018 Plans:*** Conduct acoustic sensor/atmospheric modeling field experiments to validate model resolution results; assess validity of foundation model for use in elevated dust events; and deliver sub-kilometer model configuration options to effectively link coupled land-surface and atmospheric models for improved vehicle trafficability and routing models. ***FY 2018 to FY 2019 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** H71 / *Meteorological Research For Battle Command*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
This effort was deemphasized to support other programs that more closely align to Army priorities.			
Accomplishments/Planned Programs Subtotals	6.470	6.628	5.676

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / *Military Engineering Technology*	Project (Number/Name) T40 / *Mob/Wpns Eff Tech*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
T40: *Mob/Wpns Eff Tech*	-	27.827	27.955	32.567	-	32.567	33.768	34.556	35.290	35.997	0.000	227.960

A. Mission Description and Budget Item Justification

This Project investigates, designs, and develops technologies for adaptive and expedient force protection and projection across the range of military operations. Focus areas include force projection and maneuver, including austere port and airfield entry; prediction, definition, avoidance, or defeat of natural and manmade gaps and obstacles to support ground force operations; scalable weapons effects; and high-resolution representation of near-surface terrain and environment for use with sensor models for target detection and unmanned ground systems (UGS) navigation. This research also provides physics-based representations of ground vehicle mobility, obstacle and barrier placement, survivability, and weapons effects in complex and urban terrain modeling and simulation. Work in this Project increases the protection of soldiers and critical assets from conventional, unconventional, and emerging threats and enables maneuver support of ground forces, while reducing their logistical footprint. This Project supports efforts for overcoming critical capability gaps for operations in a number of environments including dismounted Soldiers conducting missions in urban and subterranean environments, distributed small units, and projection and sustainment of forces across an increasing large battlefield.

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

The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering Science and Technology priority focus areas and the Army Modernization Priorities for Air Missile Defense and Next Generation Combat Vehicle.

This work is fully coordinated with and complementary to Program Element (PE) 0603734A (Military Engineering Advanced Technology). Autonomous ground resupply activities are coordinated in collaboration with the Tank and Automotive Research, Development and Engineering Center (TARDEC) through PE 0603005A (Combat Vehicle and Automotive Advanced Tech) / Project 515 (Robotic Ground Systems), PE 0602601A (Combat Vehicle and Automotive Technology) / Project H77 (National Automotive Center), and PE 0602601A (Combat Vehicle and Automotive Technology) / Project H91 (Ground Vehicle Technology). Autonomous Ground Resupply activities are also coordinated in collaboration with the Armament Research Development and Engineering Center (ARDEC) through PEs 0603001A (Warfighter Advanced Technology) / Project 543 (Ammunition Logistics), PE 0604639A (Weapons and Munitions - Advanced Development) / EC3 (Ammunition Logistics Prototyping), and 0605805A (Munitions Standardization, Effectiveness and Safety) / Project 297 (Mun Survivability & Log). Unconventional Countermeasure activities are coordinated with PE 0602720A (Environmental Quality Technology) / Project 835 (Mil Med Environ Crit) and PE 0603728 (Environmental Quality Technology Demonstrations) / Project 03E (Environmental Restoration Technology).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Adaptive Protection	11.058	10.988	13.834
Description: This effort develops new analytical techniques, advanced materials, and integrated protection systems to support the protection of critical assets on the battlefield. Technology development efforts include techniques and materials to protect fixed			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T40 / *Mob/Wpns Eff Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
and semi-fixed assets and soldiers in complex, urban and contested environments; techniques to increase survivability through unconventional means and advanced hardening material solutions; and techniques to identify subterranean threats against forces and critical assets. ***FY 2018 Plans:*** Develop modeling and simulation (M&S) tools to predict structural response/damage to support regional tradespace analysis; develop and improve the adaptive capabilities to rapidly and comprehensively model the blast from a wide-range of recent and emerging non-ideal HMEs in a variety of soil types and conditions; develop materials and advanced force protection decision support tools for use in complex and dense urban environments; develop advanced integrated unconventional countermeasure methods and materials to enhance survivability against advanced and emerging threats; and develop technologies to more accurately detect subterranean threats for protection of small distributed units and urban and critical assets. ***FY 2019 Plans:*** Will develop algorithms to predict a range of threat weapon effects on relevant urban construction types and design an assessment tool to ensure safe building occupation decisions; will develop and examine rapid signature reduction materials and methods to increase critical asset survivability; will develop perimeter security and surveillance technologies and algorithms to detect, track, and classify surface, maritime, and subterranean threat activities; will design and develop new protective technologies to defeat future near-peer adversarial threats. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased investment in unconventional countermeasures and protective technologies to defeat future near-peer adversarial threats.			
Title: Austere Entry and Maneuver ***Description:*** This effort investigates, designs, and creates tools and technologies that identify, assess, and monitor structural and functional suitability of theater access points and infrastructure. This effort investigates materials and models to rapidly repair or construct infrastructure to support power projection and maneuver. This effort creates tools that allow planning of distributed sustainment nodes and tactical logistics resupply networks across the complex, contested battlefield. This effort, investigates techniques and creates tools to simulate manned/unmanned tactical maneuver and mobility of small disbursed units in complex and urban terrains. ***FY 2018 Plans:*** Complete development of technologies for planning and conducting Anti-Access/Area Denial (A2/AD) entry operations without airfields/ports and with damaged/destroyed airfields/ports; develop a fused multi-component imagery and infrasound data method	12.566	11.956	13.377

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T40 / *Mob/Wpns Eff Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
for persistent critical infrastructure modeling in dynamic environments; and develop baseline model and simulation tools for autonomous ground resupply operations; and continue development of mobility decision support tools. ***FY 2019 Plans:*** Will provide an updated version of a real-time hardware-in-the-loop simulation environment to investigate autonomous vehicle maneuver; will develop software to automatically detect mobility obstacles in near-real time; will develop algorithms and begin interface design to automate analyses of seismic-infrasound-acoustic-meteorological (SIAM) data for non-subject matter expert use while monitoring infrastructure; will identify materials and technologies for modeling efforts to assess and plan projection and protection for dispersed small units in extreme, constantly evolving, and complex environments; will begin physics-based modeling efforts to predict projection material performance under repetitive loading during projection operations; will identify and examine new materials to reduce weight, increase durability, and enable rapid constructability during force projection and sustainment operations. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased investment in materials modeling for force projection.			
Title: Environmental Impacts on Sensor Performance	2.965	3.745	3.943
Description: This effort investigates, designs, and creates physics-based, multiscale numerical models of the geo-environment and synthetic environments representing geo-environment impacts on various sensor modalities and systems. These enable the development of sensors and sensor algorithms for object or target detection, sensor-target pairing, unconventional countermeasures experiments, and autonomous navigation and tactical behaviors in unmanned ground systems. This effort further investigates the design of non-line-of-sight sensors for remote areas, including the investigation of coupling between sensors and their environment for understanding surface and subsurface activities. This effort supports persistent surveillance and detection capabilities and air missile defense. ***FY 2018 Plans:*** Complete development of HPC-enabled models and advanced analytic tools combined in a simulation workflow manager; and investigate fusion of multi-sensor performance predictions and use of a tradespace framework to compare performance, cost, and availability for specific geo-environmental settings. ***FY 2019 Plans:*** Will develop computational capabilities to investigate unconventional countermeasures to enhance the protection of critical assets; and will develop new and expand current computational test bed capabilities to simulate dynamic adaptive sensing technologies in emerging threat environments. ***FY 2018 to FY 2019 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T40 / *Mob/Wpns Eff Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Planned progression of the effort.			
Title: Materials Modeling ***Description:*** This effort investigates and leverages physics-based computational models and laboratory experiments to understand the relationships between the chemical and micro-structural composition of materials and their performance characteristics when used in protecting facilities. ***FY 2018 Plans:*** Develop and validate advanced protective material solutions including novel composites, lightweight metals, ceramics, coatings, polymers, and other non-cementitious materials; continue virtual material by design development and advanced mico- and meso-scale simulations to predict engineering properties in the resultant macro-scale materials; and investigate material fabrication and manufacturing methods for layered protective systems. ***FY 2019 Plans:*** Will provide the first spiral of a virtual material by design procedure to predict engineering properties for force protection material performance; and will continue laboratory investigations of novel composites, ceramics, polymers, and other non-cementitious materials for layered force protection methods. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Planned progression of the effort.	1.238	1.266	1.413
Accomplishments/Planned Programs Subtotals	27.827	27.955	32.567

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / *Military Engineering Technology*	Project (Number/Name) T41 / *Mil Facilities Eng Tec*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
T41: *Mil Facilities Eng Tec*	-	6.104	6.457	10.699	-	10.699	10.893	11.113	11.344	11.571	0.000	68.181

A. Mission Description and Budget Item Justification

This Project investigates and develops technologies and techniques to support robotic and autonomous operations capabilities, ensure sustainable, cost efficient, and effective facilities, and to achieve resilient and sustainable installation and expeditionary operations. The project focuses on facilities and operations technologies directly supporting training, readiness, force projection, force protection, and homeland security. Facility enhancement technologies contribute to cost reductions in the Army facility life cycle process (infrastructure planning, assessment, design, construction, revitalization, sustainment, and disposal), and the supporting installation operations. This work improves the capability of autonomous engineering during combat operations to perform construction and supporting tasks in high risk/threat and dynamic environments, enables installations to support forces to meet transformation goals, improves designs for close battle training facilities, and enhances security of Soldiers, families, and civilians. Technologies evolving from this work include integrated planning and design tools for United States (U.S.) facilities and on-demand expeditionary structures, models predicting water dispersed contaminant effects on facilities and occupants; sustainable facility and base management; collaborative decision support tools; and advanced materials. In addition, technologies from this work will support analysis of socio-cultural and facility issues in contingency operations, including urban environments.

The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering Science and Technology priority focus areas and the Army Modernization Priority for Next Generation Combat Vehicle.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Infrastructure for Combat Operations (Previously titled Adaptive and Resilient Installations)	3.620	3.814	1.999
Description: The Army requires the ability to assess, establish, upgrade, and secure infrastructure while in theatre to enable deployed force operations. This effort provides tools for the assessment of physical and ecological impacts on operations, agile infrastructure modification, and custom?designed construction for expeditionary structures on?demand.			
FY 2018 Plans: Investigate potential impacts to contingency basing operational effectiveness due to location, duration, size (area and population), effects on sociocultural context, and changes in mission; and investigate and design a systematic approach to identify and model current and future permafrost and ground ice impacts on built infrastructure, operational training, and deployment design considerations in arctic and sub-arctic environments.			
FY 2019 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T41 / *Mil Facilities Eng Tec*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Will design and develop a prototype decision tool to identify types of additional design scenario variables that relate to the social, cultural, economic and political conditions that impact operational planning; and will investigate approaches to fully integrate enterprise business processes and information infrastructure across Army power projection platforms. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decreased investment to accelerate Robotics for Engineering Operations			
Title: Human Geography ? Fundamentals of Behavior and Population Dynamics ***Description:*** This effort researches population dynamics including physical, cultural, psychological, and behavioral attributes critical to United States Army engagement activities in an area of operations, including urban environments. Technology development efforts include means to identify dynamic indicators in the socio-cultural realm to assist in estimating or predicting behavioral response to operations and to display indicators in spatial-temporal views for the Warfighter. This effort complements the work in Program Element 0602784A (Military Engineering Technology) / Project 855 (Topographical, Image Intel & Space). ***FY 2018 Plans:*** Investigate methods for military assessment of population vulnerability and resilience disruptors as a result of combat, disasters, disease, etc., within dense urban and complex environments; research computational models to support a federated model approach for complex urban systems; and develop methodologies to support the military decision making process addressing the impacts of the physical, ecological, and sociocultural environments relative to contingency base site selection, design, operations and maintenance. ***FY 2019 Plans:*** Will develop a workflow and methodology to incorporate key authoritative Civil Affairs sociocultural datasets into the Army?s military decision making process for informing intelligence preparation of battlefield products for civil considerations and the commander?s critical information requirements; and will develop a computational framework to integrate multi-scale computational models of environmental, infrastructural, and social systems, enabling information support to the Joint Intelligence Preparation of the Operational Environment (JIPOE) within complex environments. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase due to inflation.	2.484	2.643	2.659
Title: Robotics for Engineer Operations ***Description:*** Develop and demonstrate robotic engineer construction equipment capability allowing Engineers to conduct autonomous and semi-autonomous Mobility, Countermobility and Construction missions. This effort supports the Army?s Modernization Priority Next Generation Combat Vehicle (NGCV), Maneuver Robotics and Autonomous Systems, and is intended to provide capabilities that enable and increase the effectiveness of future maneuver formations with extended reach (area	-	-	6.041

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T41 / *Mil Facilities Eng Tec*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
and time), by enabling increased force survivability by combining manned and robotic teaming in the conduct of cross-domain maneuver in complex terrain while reducing risk to Soldier and units. ***FY 2019 Plans:*** Will develop robotic construction equipment capabilities allowing Engineers to conduct autonomous and semi-autonomous mobility, countermobility and construction missions. Design proof of concept for a prototype robotic obstacle-removal platform, and develop advanced construction methods for deployed forces. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** New start program in FY19			
Accomplishments/Planned Programs Subtotals	6.104	6.457	10.699

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / *Military Engineering Technology*	Project (Number/Name) T42 / *Terrestrial Science Applied Research*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
T42: *Terrestrial Science Applied Research*	-	5.693	5.120	5.127	-	5.127	5.232	5.371	5.483	5.593	0.000	37.619

A. Mission Description and Budget Item Justification

This Project investigates and advances technologies to characterize and respond to impacts of the terrestrial environment on the performance of emerging and deployed Army systems, as well as the impact of natural and man-made changes in the environment on all phases of unified land operations. Research efforts model the dynamics of electromagnetic, acoustic, and seismic propagation in response to changing terrain state and complex terrain features and geometry, and their depiction in geospatial information and mission command systems. Numerical modeling of weather effects on terrain properties supports intelligence preparation of the battlefield products including mobility estimates and intelligence, surveillance, and reconnaissance planning. This effort integrates terrain knowledge and weather forecast in a mission context to provide geospatial information and mission command-delivered solutions to the Soldier. The understanding gained and products developed improve the ability to predict signature (emitter) behavior and sensor performance in complex operational environments, and support materiel development, sensor performance products for tactical decision-making, and visualization for mission command.

The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering Science and Technology priority focus areas and the Army Modernization Priority for Network/C3I.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Army Terrestrial Environmental Modeling & Intelligence System (ARTEMIS)	3.476	3.619	-
Description: This effort integrates terrain knowledge and the dynamic effects of weather and mission to provide geospatial reasoning solutions to the Soldier. The understanding gained and products developed improve the ability to predict signature behavior and sensor performance in complex operational environments, improve sensor performance products for tactical decision-making, and improve visualization for mission command. In Fiscal Year (FY)19, funds from this effort are realigned to Geospatial Analytics for High Resolution Enriched Terrain in support of the Army science and technology (S&T) priorities as identified at the December 2016 S&T Army Requirements Oversight Council by the Chief of Staff of the Army.			
FY 2018 Plans: Mature a dynamic, coupled land-atmosphere modeling and simulation capability to inform military mission planning by providing fused all-weather and all-season tactical decision aids, delivering risk-based assessments for mission specific terrain analysis, tactical movement and maneuver, and sensor planning.			
FY 2018 to FY 2019 Increase/Decrease Statement:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T42 / *Terrestrial Science Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Program transitioned to PEO IEW&S.			
Title: GeoIntelligence - Terrestrial Phenomenology Characterization for Geospatial Applications (Previously Titled Analysis for Signal & Signature Phenomenology) ***Description:*** This effort investigates the dynamics of electromagnetic, acoustic, and seismic signatures in response to changing terrain state and complex terrain geometry. Research results improve sensor employment tactics, techniques and procedures, and numerical modeling of terrain properties for tactical advantage and geospatial tactical decision aids. In FY19, funds from this effort are realigned to Geospatial Representation of Dynamic Phenomena in support of the Army science and technology (S&T) priorities as identified at the December 2016 S&T Army Requirements Oversight Council by the Chief of Staff of the Army. ***FY 2018 Plans:*** Develop algorithms for rapidly indexing and provisioning very large Light Detection and Ranging (LiDAR) point cloud collections, greatly simplifying the analyst's access to three-dimensional (3D) terrain data; and mature new web based 3D point cloud visualization and analysis capability greatly extending the data utility to the terrain analyst and image analyst. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort ends in FY18.	2.217	1.501	-
Title: Tactical Augmented Reality for Operational Technologies - 3D Terrain ***Description:*** This effort partnered with Communications - Electronics Research, Development, and Engineering Center, designs and exploits an innovative geospatial framework for storage, extraction, processing and visualization of high-resolution 3D terrain data for tactical visualization systems, helmet-mounted, and other displays. Research results will mature technological components to enable a leap ahead in Soldier situational awareness by introducing geo-registered geospatial cues with military symbology on the Soldier?s view of the real world, enabling more rapid decision making by the mounted and dismounted Warfighters. ***FY 2019 Plans:*** Will develop advanced algorithms for the detection and delineation of edges, sides, and corners of built infrastructure within collected 3D urban data, and export results as light-weight wireframe or mesh to augment the Soldier?s situational awareness in dense and congested urban and complex terrain. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** New start for FY19.	-	-	1.000
Title: Geospatial Analytics for High Resolution Enriched Terrain	-	-	3.000

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T42 / *Terrestrial Science Applied Research*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: This effort investigates and develops enhanced and automated analytical capabilities to update, revise and complete 3D high-resolution geospatial representations of the time-stable objects and geometries of complex and urban terrain (e.g. buildings) for the common operating picture. Research results, a new and innovative set of geospatial models, apply to a variety of planning and visualization capabilities for enabling the Soldier to effectively operate with greater situational awareness in complex terrain and dense urban environments. ***FY 2019 Plans:*** Will investigate emerging man/machine learning algorithms to automate production processes, to enable change detection, and to support learning by manned and autonomous systems with the capability to collect and/or complete 3D high-resolution common operating picture of complex and urban terrain. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** New start effort in FY19.			
Title: Geospatial Representation of Dynamic Phenomena ***Description:*** This effort investigates and develops capabilities for automated techniques and tools to identify, characterize, and visualize dynamic geospatial features (e.g., non-combatant clutter) to selectively overlay on high-resolution 3D geospatial representations of infrastructure and terrain surfaces for the Common Operating Picture and tactical displays. These dynamic geospatial features include natural and man-made ephemeral conditions affecting military operations (e.g., obstacles, traffic, population, degraded visual environment, snow, ephemeral water bodies, etc.), such as movement and maneuver, and sensor performance. ***FY 2019 Plans:*** Will investigate new methods to identify, characterize, track and visualize battlespace objects that change with time (examples include rubble, bridge damage, vehicles, street markets, flooding and other weather induced effects) impacting Soldier and unmanned systems movement and maneuver in complex terrain. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** New start effort in FY19.	-	-	1.127
Accomplishments/Planned Programs Subtotals	5.693	5.120	5.127

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T42 / *Terrestrial Science Applied Research*

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / *Military Engineering Technology*	Project (Number/Name) T45 / *Energy Tec Apl Mil Fac*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
T45: *Energy Tec Apl Mil Fac*	-	5.275	3.470	5.909	-	5.909	5.876	6.149	6.276	6.402	0.000	39.357

A. Mission Description and Budget Item Justification

This Project investigates and evaluates technologies necessary for secure, efficient, sustainable military installations and expeditionary structures, emphasizing systems protection in response to evolving needs, including autonomous and semi-autonomous mobility, countermobility and construction. Technologies and processes are also applied to the Army's industrial base to maintain its cost-effective readiness for munitions production and training, and in the theater of operations to reduce logistical footprint. This effort investigates technologies to assess, establish, upgrade, and secure infrastructure while in theatre to enable deployed force operations, develops methods to optimize sustainable operations and maintenance to minimize lifecycle costs, and provides capabilities that enable future maneuver formations. In addition, technologies from this work mature a better understanding of critical infrastructure interdependencies to support sustainable and flexible facility operations and evolving mission requirements.

Work in this Project supports the Army Science and Technology Environment and Terrain Portfolio.

The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering Science and Technology priority focus areas and the Army Modernization Priority for Next Generation Combat Vehicle.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Infrastructure for Combat Operations (Previously titled Adaptive and Resilient Installations)	5.275	3.470	-
Description: The Army requires the ability to assess, establish, upgrade, and secure infrastructure while in theatre to enable deployed force operations. This effort provides tools for the assessment of physical and ecological impacts on operations, agile infrastructure modification, and custom?designed construction for expeditionary structures on?demand ***FY 2018 Plans:*** Develop a tool for efficient siting of contingency bases, informing real estate decisions made between the United States (U.S.) and a host nation during Phase Zero operations to inform military planners of potential impacts to operational effectiveness due to location, duration, size (area and population), effects on sociocultural context, and changes in mission; and assess the relative risk associated with contingency construction activities and investigate risk mitigation frameworks through the employment of autonomous construction methods. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort ends in FY18.			
Title: Robotics for Engineer Operations	-	-	5.909

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602784A / *Military Engineering Technology*	**Project (Number/Name)** T45 / *Energy Tec Apl Mil Fac*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: Develop and demonstrate robotic engineer construction equipment capability allowing Engineers to conduct autonomous and semi-autonomous Mobility, Countermobility and Construction missions. This effort supports the Army?s Modernization Priority Next Generation Combat Vehicle (NGCV), Maneuver Robotics and Autonomous Systems, and is intended to provide capabilities that enable and increase the effectiveness of future maneuver formations with extended reach (area and time), enabling increased force survivability by combining manned and robotic teaming in the conduct of cross-domain maneuver in complex terrain while reducing risk to Soldier and units. ***FY 2019 Plans:*** Develop robotic construction capabilities for forward deployed Engineers. This includes autonomous site characterization for construction; debris and obstacle removal; horizontal infrastructure repair; obstacle emplacement; control methodologies for multiple robotic construction equipment to work collaboratively and cooperatively, and additive printing using concrete or other cementitious materials for onsite implementation and use. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Effort initiates in FY19			
Accomplishments/Planned Programs Subtotals	5.275	3.470	5.909

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602784A / *Military Engineering Technology*	Project (Number/Name) T53 / *Military Engineering Applied Research (CA)*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
T53: *Military Engineering Applied Research (CA)*	-	23.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	23.000

Note

Congressional increases for Program increase

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Military Engineering applied research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Program Increase	23.000	-
FY 2017 Accomplishments: N/A		
Congressional Adds Subtotals	23.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602785A / *Manpower/Personnel/Training Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	23.475	20.216	21.862	-	21.862	23.651	24.176	24.261	24.659	0.000	162.300
790: *Personnel Performance & Training Technology*	-	23.475	20.216	21.862	-	21.862	23.651	24.176	24.261	24.659	0.000	162.300

A. Mission Description and Budget Item Justification

This Program Element (PE) conducts applied behavioral and social science research to enhance the Soldier Lifecycle (e.g., selection, assignment, training, leader development) and human relations (e.g., unit cohesion). This PE develops new personnel measures and methods that more fully assess potential and predict performance, behavior, attitudes, and resilience. These technologies also provide innovative and effective Talent Management methods to optimize individual and team performance to ensure the Army can meet mission requirements in uncertain and complex environments. This PE develops new performance measures and metrics for individuals and units, designs innovative training methods, and conducts scientific assessments to inform Human Capital policy and programs. Research in this PE will result in effective non-materiel solutions to help the Army adjust to changes in force size and structure, a variety of mission demands and contexts, challenges in human relations, and budgetary constraints.

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

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

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

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	26.045	20.216	21.902	-	21.902
Current President's Budget	23.475	20.216	21.862	-	21.862
Total Adjustments	-2.570	0.000	-0.040	-	-0.040
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	-	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-2.563	-			
• Adjustments to Budget Years	-	-	-0.040	-	-0.040
• FFRDC	-0.007	-	-	-	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602785A / *Manpower/Personnel/ Training Technology*	Project (Number/Name) 790 / *Personnel Performance & Training Technology*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
790: *Personnel Performance & Training Technology*	-	23.475	20.216	21.862	-	21.862	23.651	24.176	24.261	24.659	0.000	162.300

A. Mission Description and Budget Item Justification

This Project conducts applied behavioral and social science research to enhance the Soldier Lifecycle (e.g., selection, assignment, training, leader development) and human relations (e.g., unit cohesion). This Project develops new personnel measures and methods that more fully assess potential and predict performance, behavior, attitudes, and resilience. These technologies also provide innovative and effective Talent Management methods to optimize individual and team performance to ensure the Army can meet mission requirements in uncertain and complex environments. This Project develops new performance measures and metrics for individuals and units, designs innovative training methods, and conducts scientific assessments to inform Human Capital policy and programs. Research in this Project will result in effective non-materiel solutions to help the Army adjust to changes in force size and structure, a variety of mission demands and contexts, challenges in human relations, and budgetary constraints.

Efforts in this Project support the Army Science and Technology (S&T) Soldier portfolio.

The cited work is consistent with the S&T priorities of the Army Chief of Staff, Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Human Capital Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Personnel Measures and Assessments	11.742	9.000	12.568
Description: Conduct applied research that provides the Army with improved prediction and modeling of potential performance, behaviors, attitudes, and resilience of Soldiers, as well as an improved ability to recruit and sustain an effective career force.			
FY 2018 Plans: Conduct research on developing integrated assessments (i.e., comprehensive (vs. single) personnel assessments) for predicting high-potential Soldiers and high-risk behavior (i.e., integrated measures collected across the Soldier Lifecycle that feeds holistic assessments and predictive models of behaviors, performance, and outcomes).			
FY 2019 Plans: Will conduct research to develop a vocational interest inventory for increased prediction and selection of assignment and performance within select critical Military Occupational Specialties (e.g. cyberwarfare); conduct research for the application of non-cognitive measures to inform branching choices for cadets to support sustainment of professional military careers and reduce			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602785A / *Manpower/Personnel/ Training Technology*	**Project (Number/Name)** 790 / *Personnel Performance & Training Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Soldier attrition costs; conduct research in Big Data applications to develop automatically generated test items for personnel assessment. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased funding in Personnel Measures and Assessment to accelerate research in applying Big Data approaches to personnel assessment, performance modeling, and career modeling.			
Title: Personnel Readiness and Performance ***Description:*** This effort funds research to provide the Army with effective leader assessment, development, and training methods to measure, develop, and sustain individual/leader competencies and performance across the Soldier lifecycle. ***FY 2018 Plans:*** Conduct research to develop holistic training methods to help officers and non-commissioned officers (NCOs) enhance and sustain unit resilience; conduct research to create integrated assessments of individual Soldier and unit readiness by researching holistic training methods that combine traditional and lecture-based training with integrative learning methods and training techniques that allow for connections among concepts/experiences so that information/skills can be applied to novel and complex issues or challenges). ***FY 2019 Plans:*** Will conduct research to develop methods for assessing and developing complex leader competencies to perform effectively in multi-domain operations (e.g., systems and strategic thinking). ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Decreased funding to support the acceleration of Personnel Measures and Assessments. The decrease in funding delays research in creating methods to accelerate expertise development.	5.668	7.506	3.894
Title: Unit Performance and Cohesion ***Description:*** Previously titled ?Unit Readiness,? this effort conducts applied research to ensure cohesive, high performing teams for future operational environments. This effort develops methods to optimize team composition to enhance unit performance, methods to rapidly build and sustain team cohesion, and assessments of unit performance to shape collective training and inform unit readiness indicators. ***FY 2018 Plans:*** Conduct research to develop methods and tools that enable Army leaders to build improved morale, cohesion, and readiness in small units; conduct research to identify and measure command climate factors that predict overall unit readiness. ***FY 2019 Plans:***	6.065	3.710	5.400

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602785A / *Manpower/Personnel/ Training Technology*	**Project (Number/Name)** 790 / *Personnel Performance & Training Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Will conduct research to develop empirically-validated climate assessments based on objective behaviors (e.g., behavior checklists, unobtrusive measures) that efficiently and accurately assess key aspects of command climate; conduct research to develop methods to assess cohesion in non-traditional teams (e.g., dispersed, diverse, new tasks/missions). ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increased funding will be applied to research in developing methods to assess cohesion in non-traditional teams.			
Accomplishments/Planned Programs Subtotals	23.475	20.216	21.862

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army												Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602786A / *Warfighter Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	59.327	39.559	40.566	-	40.566	44.085	43.663	44.692	45.583	0.000	317.475
283: *Airdrop Adv Tech*	-	3.396	3.818	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	7.214
E01: *Warfighter Technology Initiatives (CA)*	-	22.700	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	22.700
H98: *Clothing & Equipm Tech*	-	25.979	27.450	30.393	-	30.393	33.821	33.483	34.548	35.236	0.000	220.910
H99: *Joint Service Combat Feeding Technology*	-	4.867	5.051	4.896	-	4.896	5.007	5.157	5.410	5.518	0.000	35.906
VT4: *Expeditionary Mobile Base Camp Technology*	-	2.385	3.240	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.625
XW5: *Small Unit Expeditionary Maneuver Technology*	-	0.000	0.000	5.277	-	5.277	5.257	5.023	4.734	4.829	0.000	25.120

Note

In FY19, work is realigned from Projects 283 (Airdrop Adv Tech) and VT4 (Expeditionary Mobile Base Camp Technology) to XW5 (Small Unit Expeditionary Maneuver Technology).

A. Mission Description and Budget Item Justification

This Program Element (PE) investigates and develops integrated technologies which improve Soldier and Small Combat Unit survivability, sustainability, mobility, combat effectiveness, and field quality of life and assess the impact of each on Soldier performance. This PE supports the design, development, and improvement of components used for aerial delivery of personnel and cargo (Project 283), combat clothing and personal equipment including protective equipment such as personal armor, helmets, and eyewear (Project H98), combat rations and combat feeding equipment (Project H99), expeditionary base camps (Project VT4), small unit expeditionary maneuver technologies (Project XW5). This PE supports the investigation and advancement of critical knowledge and understanding of Soldier physical and cognitive performance. Project E01 funds Congressional special interest items. The Projects in this PE adhere to Tri-Service Agreements on clothing, textiles, and food with coordination provided through the Cross Service Warfighter Equipment Board, the Soldier and Squad Integrated Concepts Development Team, and the Department of Defense (DoD) Combat Feeding Research and Engineering Board.

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

Work in this PE is related to, and fully coordinated with, PE 0603001A (Warfighter Advanced Technology), PE 0602105A (Materials Technology), PE 0602618A (Ballistics Technology), PE 0602787A (Medical Technology Initiatives), PE 0602716A (Human Factors Engineering Technology), 0603004A (Weapons and Munitions

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army	Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*

Advanced Technology), PE 0603005A (Combat Vehicle and Automotive Advanced Technology), PE 0602784A (Military Engineering Technology), PE 0603125A (Combating Terrorism Technology Development), and PE 0603772A (Advanced Tactical Computer Science and Sensor Technology).

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

Work is led, performed, and/or managed by the Research, Development, and Engineering Command (RDECOM).

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	37.403	39.559	45.691	-	45.691
Current President's Budget	59.327	39.559	40.566	-	40.566
Total Adjustments	21.924	0.000	-5.125	-	-5.125
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	22.700	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-0.865	-			
• Adjustments to Budget Years	0.100	-	-5.125	-	-5.125
• FFRDC	-0.011	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: E01: *Warfighter Technology Initiatives (CA)*		
Congressional Add: *Program Increase*	10.000	-
Congressional Add: *H98 clothing and equipment*	5.000	-
Congressional Add: *Advanced active environmental control technology for expeditionary mobile base*	6.000	-
Congressional Add: *Soldier protection*	1.700	-
Congressional Add Subtotals for Project: E01	22.700	-
Congressional Add Totals for all Projects	22.700	-

Change Summary Explanation

Fiscal Year (FY) 2017 Congressional increase in E01 Warfighter Technology Initiatives.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army	Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*

FY19 funding reduction accommodates funding shifts that support higher priority efforts that align to senior leader priorities for Soldier Lethality.

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602786A / *Warfighter Technology*	Project (Number/Name) 283 / *Airdrop Adv Tech*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
283: *Airdrop Adv Tech*	-	3.396	3.818	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	7.214

Note

In FY19, work is realigned from Project 283 (Airdrop Adv Tech) to Project XW5 (Small Unit Expeditionary Maneuver Tech)

A. Mission Description and Budget Item Justification

This Project funds the research and investigation of component technologies to enhance cargo and personnel airdrop capabilities for global precision delivery, rapid deployment, and insertion for force projection into hostile regions. Areas of emphasis include parachute technologies, parachutist injury reduction, precision offset aerial delivery, soft landing technologies, and airdrop simulation.

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

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

Work in this Project is fully coordinated with Program Element (PE) 0603001A (Warfighter Advanced Technology).

In FY19, work in this project realigns into XW5, titled Small Unit Expeditionary Maneuver Tech, along with VT4 Expeditionary Mobile Base Camp Technology.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Airdrop/Aerial Delivery Research and Technology	3.396	3.818	-
Description: This effort investigates technologies that enhance payload extraction, increase parachute gliding capabilities, and mature delivery accuracy of cargo aerial delivery systems that support varying payload weights. Research in the area of novel parachute materials will provide increased capabilities for cargo and personnel aerial delivery systems. This effort will support an investigation of new Modeling and Simulation (M&S) tools in order to develop validation methods for airdrop concepts. This effort also investigates technologies that advance airborne personnel insertion safety and security. This work is coordinated with PE 0603001A/Project 242/XW6. In Fiscal Year (FY) 2019, work in this Project is realigned into XW5, titled Small Unit Expeditionary Maneuver Tech, along with H99, Joint Service Combat Feeding Technology and VT4, Expeditionary Mobile Base Camp Technology.			
FY 2018 Plans: Conduct modeling & simulation (M&S) supporting aerial delivery system analyses to establish a baseline for personnel and cargo airdrop systems utilizing several high- and low-fidelity M&S tools; investigate and analyze results of full-scale wind tunnel experiments and methods for determining parachute shelf/service life; mature software algorithms that support the static line			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** 283 / *Airdrop Adv Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
reserve parachute automatic activation sensor technologies in order to better detect parachute malfunctions and record and analyze jump data; investigate precision airdrop enhancements that will expand GPS-denied capabilities to include nighttime operations and design control systems to enhance low-cost airdrop system accuracy. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY19 funding in this Project will be moved to Project XW5, accomplishment title Aerial Delivery, in order to meet senior leader priorities for Soldier Lethality.			
Accomplishments/Planned Programs Subtotals	3.396	3.818	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602786A / *Warfighter Technology*	Project (Number/Name) E01 / *Warfighter Technology Initiatives (CA)*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
E01: *Warfighter Technology Initiatives (CA)*	-	22.700	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	22.700

Note

Congressional Increase

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Warfighter Technology Applied Research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Program Increase ***FY 2017 Accomplishments:*** N/A	10.000	-
Congressional Add: H98 clothing and equipment ***FY 2017 Accomplishments:*** N/A	5.000	-
Congressional Add: Advanced active environmental control technology for expeditionary mobile base ***FY 2017 Accomplishments:*** N/A	6.000	-
Congressional Add: Soldier protection ***FY 2017 Accomplishments:*** N/A	1.700	-
Congressional Adds Subtotals	22.700	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602786A / *Warfighter Technology*	Project (Number/Name) H98 / *Clothing & Equipm Tech*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H98: *Clothing & Equipm Tech*	-	25.979	27.450	30.393	-	30.393	33.821	33.483	34.548	35.236	0.000	220.910

A. Mission Description and Budget Item Justification

This Project investigates fibers, textiles, components, and materials focused on enhancing Soldier survivability from combat threats (flame and thermal, blast and ballistic, multispectral sensor, and laser threats) and environmental threats (e.g., cold, heat, wet, vector, antimicrobial, etc.) to increase operational effectiveness while decreasing the Soldier's physical and cognitive burden. Included are investigations of technologies, novel materials, and test methods related to personnel armor, helmets, hearing protection, eyewear, uniforms, handwear, footwear, and other clothing and individual equipment items. This Project also supports the investigation and development of novel combat identification technologies, electro-textiles for power generation and distribution, the study and exploration of algorithms for autonomous micro and nano robotics and sensors, and human-machine teaming technologies to enhance the dismounted Soldier's Situational Awareness (SA) and Manned-Unmanned Teaming (MUMT) with autonomous systems. In addition, this Project supports the development and refinement of essential analytic tools needed to predict and/or assess the combat effectiveness of next generation Soldier systems to identify and develop methods to assess human responses to sensory, physical, cognitive, and affective stimuli and stressors.

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

Work in this Project is coordinated with Program Element (PE) 0602105A (Materials Technology), PE 0602618A (Ballistics Technology), PE 0603001A (Warfighter Advanced Technology), PE 0602787A (Medical Technology Initiatives), and PE 0602716A (Human Factors Engineering Technology).

The cited work is consistent with the S&T priorities of the U.S. Chief of Staff, Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Soldier Blast, Ballistic, and Sensory Protection	6.779	13.452	11.330
Description: This effort supports the investigation of novel materials, component design, and material modeling to design and develop technologies that protect Soldiers against ballistic, blast, and directed energy threats. This effort utilizes a cross-disciplinary, human-focused approach to develop technologies which optimize tradeoffs in ballistic and blast protective component design. This effort is fully coordinated with PE 0602787A/Project FH2, PE 0602787A/Project VB3, PE 0602787A/Project 874, PE 0602618A/H80, PE0602105A/Project H84, PE0602716A/Project H70, PE 0603001A/Project J50, and PE 0603001A/Project FF6. This effort supports the Force Protection Soldier & Small Unit capability research and addresses the Army top challenge of easing overburdened Soldiers in small units.			
FY 2018 Plans: Conduct experiments to determine the efficacy of a combat helmet ballistic test methodology tied to modeling capabilities that correlate results with behind helmet blunt trauma injury; investigate new energy absorbing materials and subsystem components			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** H98 / *Clothing & Equipm Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
for helmet blunt impact protection systems; mature casualty reduction assessment tools and modeling capability; conduct experiments on next generation fiber technologies and material processing techniques with potential for enhancing fiber strength and advancing ballistic protection at reduced weight; validate pixelated lens technology applied on a ballistic fragmentation eyewear lens platform with ability to respond and protect against point and broadband light sources; determine the ability to detect and locate exposure to non-visible laser sources and other threats; investigate high transmission laser eye protection technology and evaluation procedures; conduct experiments on hard armor torso protection ceramic and composite backing materials to explore significant weight reduction opportunities; fund research to investigate alternative or new test methods and corresponding modeling and simulation for torso protection. ***FY 2019 Plans:*** Will research new technologies for an integrated, single lens that incorporates multiple capabilities into the Soldier vision protection system, including variable transmission lenses with flash protection, laser dazzle and frequency agile pulsed/continuous wave laser protection, and an environmentally- hardened, ballistic fragmentation platform lens with high visual transmission; design and develop cost effective and repeatable laboratory test method that is capable of evaluating the performance of head-borne equipment in a simulated free-field blast overpressure environment; develop research tools to assist the development of a transfer function enabling the scaling of head injury criteria from animal testing to humans to inform future helmet performance requirements based on injury biomechanics; investigate pre-stress and temperature conditioning methods to preserve and/or increase ballistic material mechanical properties during composite laminate processing to enhance ballistic performance; research fundamental understanding of the role of processing-structure-property relationships in ballistic composites, in particular, the role of microstructure on ballistic performance; investigate the penetration mechanics and effectiveness of sphere projectiles against woven armor packages via deconstruction and analysis of individual fabric plies. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduction in funding as the effort supporting casualty reduction assessment tools and modeling is ending.			
Title: Soldier Vision Protection and Enhancement ***Description:*** This effort focuses on the investigation of technologies that provide eye protection against battlefield threats. This effort supports the Force Protection Soldier and Small Unit capability research and addresses the Army top challenge of easing overburdened Soldiers in small units. This effort is fully coordinated with PE 0602787A/Project FH2, PE 0602787A/Project VB3, PE 0602787A/Project 874, PE 0602618A/H80, PE0602105A/Project H84, PE0602716A/Project H70, PE 0603001A/Project J50, and PE 0603001A/Project FF6. In Fiscal Year (FY) 18, this effort will be incorporated into this PE's Soldier Blast, Ballistic, and Sensory Protection Program.	2.900	-	-
Title: Measurement, Prediction, and Improvement of Soldier Performance ***Description:*** This effort provides a comprehensive investigation of human science methods (psychological, anthropometric, and psychophysical) and biomechanical models to assess human responses to sensory, physical, cognitive, and affective stimuli and	9.200	7.863	8.828

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** H98 / *Clothing & Equipm Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
stressors. This investigation supports the development of human systems design concepts for Soldier equipment and enhances Soldier and small unit physical and cognitive performance. This work is collaborative with the Army Research Laboratory PE 0602716A/H70 and the Medical Research and Materiel Command PE 0602787A/Project FH2, PE 0602787A/Project VB3, and PE 0602787A/Project 874. This effort supports the Force Protection Soldier & Small Unit capability research and addresses the Army top challenge of easing overburdened Soldiers in small units. ***FY 2018 Plans:*** Investigate the utility of non-invasive physical human performance metrics data collection with respect to specific Warfighter tasks; continue to conduct experiments that monitor, predict, and optimize cognitive, physical, and social measures of the Soldier; validate common criteria for measures of Soldier performance while conducting military relevant tasks; investigate the validity, reliability, and sensitivity of obstacles utilized within the Load Effects Assessment Program (LEAP); validate interactions and physical interfaces between the Soldier, equipment, and physical tasks; mature benchtop representation of the Warfighter?s gut microbiome model to investigate and characterize the effects of dietary inputs on the performance of a Soldier?s internal anatomy; research and conduct experiments to understand the physiological mechanisms necessary to advance a Soldier?s natural physical and cognitive abilities. ***FY 2019 Plans:*** Will design tools to predict Soldier comprehension of information in a dense urban and technology laden terrain by conducting experiments of cognitive function in immersed/simulated environments and then will develop predictive algorithms for decision making at platoon-level operations; investigate and validate human performance metrics for system design in support of emerging situational awareness efficacy of cuing techniques in augmented and mixed reality as well as the intervention of neuro-stimulation to optimize cognitive performance; investigate and validate human performance metrics for system design in support of emerging mobility enhancement to determine the most efficient control scheme and joint augmentation needs of the lower extremity; investigate and validate human performance metrics in support of emerging expeditionary maneuver support by maturing an in vitro gut microbiome model that could deter gastrointestinal distress; design digital humans to inform space claims and human factors engineering considerations for all platforms inhabited or utilized by a Soldier. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding increased to support work in the area of exoskeleton control schemes and joint augmentation needs of the lower extremity.			
Title: Advancements in Fibers, Textiles, and Materials for Soldier Protection	7.100	6.135	7.760
Description: This effort focuses on the investigation of technologies and test methods that aid in the design and development of multifunctional protective materials for Soldier clothing and individual equipment. This effort includes the development and maturation of flame, thermal, environmental, and multispectral concealment capabilities, as well as novel desalinization and purification technologies for individual Soldier hydration, combat identification technologies, and electro-textiles for power			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** H98 / *Clothing & Equipm Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
generation and distribution. This effort supports the Force Protection Soldier and Small Unit capability research. This effort is fully coordinated with PE0602105A/Project H84, PE0602716A/Project H70, and PE 0603001A/Project J50. ***FY 2018 Plans:*** Investigate and develop desalination capabilities for individual Soldier hydration systems; design and develop novel textile architectures and weaves to provide protection against microwave frequency hazards through reflection and scattering of directed energy threats; investigate quantum dots and novel film applications as possible mechanisms to improve combat identification; investigate and develop microrectenna arrays for Soldier worn combat identification and energy conversion; investigate thermally adaptive fibers and technologies which provide improved thermal protection in cold and extreme cold weather environments; investigate carbon based conductive fibers and flexible materials for incorporation into textiles for optimized Soldier worn energy distribution. ***FY 2019 Plans:*** Will investigate and develop optical film (VOF) technology for standoff-based signature concealment in a variety of spectral ranges to achieve concealment performance for Soldier uniforms; investigate multifunctional materials suitable for signature management/decoy and high mobility mission command applications to enable on-demand resupply capabilities; develop novel textile architectures and weaves to provide protection against microwave frequency hazards through reflection and scattering of directed energy threats; investigate the principles of motion versus conspicuity effects on observer perception and apply these principles to simulated real-world operational scenes to evaluate Soldier camouflage; investigate and develop novel sensor systems for measuring heat flux during system and sub-system flame resistance testing to capture the most susceptible burn injury body regions; mature infrared microrectenna arrays to demonstrate wireless power transfer and data communications embedded in the Soldier clothing and individual equipment. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding increase to support the development of optical film (VOF) technology for standoff-based signature concealment for Soldier uniforms.			
Title: Soldier Situational Awareness Technologies ***Description:*** This effort investigates novel technologies that enhance the dismounted Soldier and Small Unit?s Situational Awareness (SA) during missions. Research in the area of advanced algorithms for Soldier deployed sensors and robotics will provide advanced autonomy to enable Manned-Unmanned Teaming (MUM-T) capabilities for the dismounted Small Unit. This effort also investigates advanced human-machine teaming technologies to minimize warfighter dedicated control of robotic assets. Work in this Project is coordinated with Program Element (PE) 0603001A (Warfighter Advanced Technology). ***FY 2019 Plans:***	-	-	2.475

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** H98 / *Clothing & Equipm Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Will investigate and mature advanced algorithms and sensors for micro and nano robotic systems to enhance autonomy and provide collision avoidance, environmental sensing, and global positioning system (GPS) denied navigation capabilities; will investigate novel Soldier-robotic interfaces and interaction modalities to enhance human-machine teaming; will investigate micro and nano sensors and robotic platforms, payloads, and architectures to enable Manned-Unmanned Teaming of autonomous systems with dismounted Soldiers. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Investment supports S&T strategy of increased Soldier Situational Awareness in a variety of hostile environments.			
Accomplishments/Planned Programs Subtotals	25.979	27.450	30.393

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602786A / *Warfighter Technology*	Project (Number/Name) H99 / *Joint Service Combat Feeding Technology*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
H99: *Joint Service Combat Feeding Technology*	-	4.867	5.051	4.896	-	4.896	5.007	5.157	5.410	5.518	0.000	35.906

A. Mission Description and Budget Item Justification

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

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

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

The cited work is consistent with the S&T priorities of the U.S. Chief of Staff, Assistant Secretary of Defense for Research and Engineering Science and Technology priority focus areas and the Army Modernization Strategy.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Joint Combat Feeding Technologies	4.867	5.051	4.896
Description: This effort designs and develops stabilization techniques and nutrient compositions to maximize the Warfighter's cognitive and physical performance while minimizing nutritional degradation to optimize the Warfighter's health on the battlefield. This effort investigates technologies in support of the Defense Health Agency Veterinary Services (DHA VS) to enhance field detection and identification capabilities of chemical and biological threats in foods. This effort supports the design and development of new threat detection tools and sensors for food inspectors. This effort additionally investigates equipment and energy technologies to expand the capability and reduce the logistics footprint of Joint Service field feeding operations in a wide range of environmental and operational contexts. This work is coordinated with PE 0602787A/Project 869 and PE 0603001A/ Project C07.			
FY 2018 Plans: Develop ration formulations containing proven nutritional strategies to optimize the gut microbiome and improve warfighter cognitive performance under stressful conditions; investigate heat transfer methods to enable high efficiency operation of field feeding appliances while reducing power requirements; identify nutritional interventions that promote recovery from strenuous exercise or mitigate oxidative stress; investigate portable biosensor detection platforms to improve food safety; design alternative			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** H99 / *Joint Service Combat Feeding Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
packaging configurations that decrease ration weight; validate improved nutrient content of foods processed using non-thermal or low-thermal methods to improve warfighter nutritional status; develop model food formulations that retain desired sensory characteristics after creation via three-dimensional (3D) printing. ***FY 2019 Plans:*** Will study, design, and conduct experiments investigating technologies capable of rapidly detecting adulterated food items prior to consumption, particularly in limited re-supply and austere environments; conduct clinical studies to determine the effect of targeted nutritional strategies on gut and immune health; investigate food processing technologies that increase nutrient retention while meeting shelf life requirements. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduction in funding as heat transfer methods effort is ending.			
Accomplishments/Planned Programs Subtotals	4.867	5.051	4.896

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602786A / *Warfighter Technology*	Project (Number/Name) VT4 / *Expeditionary Mobile Base Camp Technology*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
VT4: *Expeditionary Mobile Base Camp Technology*	-	2.385	3.240	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	5.625

Note

In FY19, work is realigned from Project VT4 (Expeditionary Mobile Base Camp Technology) to Project XW5 (Small Unit Expeditionary Maneuver Tech)

A. Mission Description and Budget Item Justification

This Project matures and validates fully integrated holistic expeditionary base camp (EBC) capabilities with mission-specific plug and play components, subsystems, and modules designed to optimize manpower requirements, enhance situational awareness, increase Soldier readiness and survivability, optimize habitation, reduce logistics footprint, enhance supportability, and reduce cost. EBC systems provide an operational capability for small combat units (battalion and below) and Soldiers in varying environments, which are rapidly deployable and re-locatable, require no Military Construction, and need limited materiel handing support. This Project matures technologies that can be combined to create mission specific lab demonstrators and develops metrics and methodologies to measure performance characteristics.

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

Work in this Project is fully coordinated with Program Element (PE) 0602784A and 0603734A (Military Engineering Technology), PE 0603001A (Warfighter Advanced Technology), PE 0603004A (Weapons and Munitions Advanced Technology), PE 0603005A (Combat Vehicle and Automotive Advanced Technology), PE 0603125A (Combating Terrorism Technology Development), and PE 0603772A (Advanced Tactical Computer Science and Sensor Technology).

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

In Fiscal Year 2019, work in this Project realigns into XW5, titled Small Unit Expeditionary Maneuver Tech, along with 283 Airdrop Adv Tech.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Expeditionary Base Camp Component Technologies	2.385	3.240	-
Description: This effort investigates base camp component interoperability and matures and scales component technologies for an integrated holistic base camp concept. This effort supports the basing sustainment and logistics capability investigation. This work is coordinated with PE 0603001A/Project VT5/XW5, PE 0602786A/Project H99 and is coordinated with PE 0602784A/ Project T40, PE 0603734A/Project T08, PE 0603004A/Project L97, PE 0603005A/Project 497, PE 0603125A/Project DF5, and PE 0603772A/Project 101. In FY19, work in this Project realigns into XW5, titled Small Unit Expeditionary Maneuver Tech, along with 283, titled Airdrop Adv Tech and H99, titled Joint Service Combat Feeding Technology.			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** VT4 / *Expeditionary Mobile Base Camp Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY 2018 Plans: Identify operational effectiveness measures and explore correlation between expeditionary maneuver, base camp sustainment, and operational quality of life optimized for Soldier readiness in order to incorporate mission effectiveness into the development of self-sufficient base camp technology; investigate alternative energy technologies to improve efficiency, durability, and adaptability to a base camp environment; mature thermal insulation material to enhance energy efficiency for expeditionary shelter; investigate technical approaches for expeditionary structures to mitigate visual, thermal, and electromagnetic infrared signatures; validate ballistic protective shelter material and design technologies with simulated emerging threats; investigate concepts of additive manufacturing technologies for in-theatre shelter component fabrication to reduce overall logistics tail. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY19 funding in this Project will be moved to Project XW5, accomplishment title Expeditionary Maneuver, in order to meet senior leader priorities.			
Accomplishments/Planned Programs Subtotals	2.385	3.240	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602786A / *Warfighter Technology*	Project (Number/Name) XW5 / *Small Unit Expeditionary Maneuver Technology*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
XW5: *Small Unit Expeditionary Maneuver Technology*	-	0.000	0.000	5.277	-	5.277	5.257	5.023	4.734	4.829	0.000	25.120

Note

In FY19, work is realigned from Projects 283 (Airdrop Adv Tech) and VT4 (Expeditionary Mobile Base Camp Technology) to XW5 (Small Unit Expeditionary Maneuver Technology).

A. Mission Description and Budget Item Justification

The Small Unit Expeditionary Maneuver Technology Project funds the research and investigation of innovative and emerging technologies which provide maneuver capabilities such as precision aerial delivery of cargo and personnel and force projection platforms enabling mission command in all operating environments. This Projects provides trusted tactical sustainment for dispersed units in highly mobile dismounted Manned-UnManned Teaming (MUM-T) operations and other complex operating environments. Efforts funded in this Project support all Military Services, the Special Operations Command, and the Defense Logistics Agency. Technologies developed within this effort transition to Program Element (PE) 0603001A/Project XW6 for maturation.

Efforts in this Project support the Army Science and Technology (S&T) Soldier Portfolio.

The cited work is consistent with the S&T priorities of the U.S. Army Chief of Staff, Assistant Secretary of Defense for Research and Engineering priority focus areas, and the Army Modernization Strategy.

Project XW5 combines the efforts of Project 283 and VT4 in FY19 to create an integrated expeditionary maneuver research focus area.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Aerial Delivery	-	-	3.777
Description: This effort designs and develops technologies that enable Soldier and Small Unit mission readiness, survivability, and effectiveness during highly mobile, dispersed operations that may occur in the absence of conventional logistics support. This effort investigates technologies that enhance equipment, materiel, and personnel aerial delivery in an Anti-Access, Area Denial (A2/AD) environments.			
FY 2019 Plans: Will study, design, and conduct experiments with precision aerial delivery software and hardware components to enhance precision aerial delivery capabilities and assure re-supply via manned and unmanned systems in A2/AD environments; conduct			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602786A / *Warfighter Technology*	**Project (Number/Name)** XW5 / *Small Unit Expeditionary Maneuver Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
research in the area of maneuver assistance in personnel airdrop systems to accelerate the certification of airborne jumpers from novice to master jumper. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY19 funding was moved from Project 283, accomplishment title Airdrop/Aerial Delivery Research and Technology, in order to meeting senior leader priorities for Soldier Lethality.			
Title: Expeditionary Maneuver ***Description:*** This effort designs and develops technologies that enable Soldier and Small Unit mission readiness, survivability, and effectiveness during highly mobile, dispersed operations that may occur in the absence of conventional logistics support. This effort investigates system designs and technologies to enable mission command through highly mobile expeditionary maneuver platforms, signature management, and production of energy/supplies at the point of consumption to provide small units with the capability to move rapidly, while providing improved protection and extended range. ***FY 2019 Plans:*** Will study, design, and conduct experiments that investigate autonomous deployment methodologies, additive manufacturing of components used in expeditionary maneuver platforms that support expeditionary operations in all environments, and concepts for rapidly-deployable platforms that allows for integration of technologies that will improve protection and minimize resource consumption. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** FY19 funding was moved from Project VT4, accomplishment title Expeditionary Base Camp Component Technologies, in order to meeting senior leader priorities.	-	-	1.500
Accomplishments/Planned Programs Subtotals	-	-	5.277

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army											Date: February 2018	
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*					R-1 Program Element (Number/Name) PE 0602787A / *Medical Technology*							
COST ($ in Millions)	**Prior Years**	**FY 2017**	**FY 2018**	**FY 2019 Base**	**FY 2019 OCO**	**FY 2019 Total**	**FY 2020**	**FY 2021**	**FY 2022**	**FY 2023**	**Cost To Complete**	**Total Cost**
Total Program Element	-	78.341	83.434	90.075	-	90.075	94.708	93.828	96.041	97.431	0.000	633.858
869: *Warfighter Health Prot & Perf Stnds*	-	36.586	40.201	35.777	-	35.777	39.136	41.246	42.110	42.803	0.000	277.859
870: *Dod Med Def Ag Inf Dis*	-	20.841	22.234	21.651	-	21.651	22.081	19.405	19.813	20.209	0.000	146.234
874: *Cbt Casualty Care Tech*	-	9.849	11.127	12.781	-	12.781	14.944	15.063	15.431	15.615	0.000	94.810
ET4: *Appl Resch in Clinical and Rehabilitative Medicine*	-	6.993	7.871	12.138	-	12.138	7.133	6.392	6.402	6.241	0.000	53.170
VB3: *MEDICAL TECHNOLOGY INITIATIVES (CA)*	-	2.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	2.000
VB4: *System Biology And Network Science Technology*	-	2.072	2.001	2.008	-	2.008	2.050	2.099	2.143	2.187	0.000	14.560
XV5: *Medical Capabilities to Support Dispersed Operations*	-	0.000	0.000	5.720	-	5.720	9.364	9.623	10.142	10.376	0.000	45.225

Note

Funding for Medical Simulation and Information Sciences in project XV5 begins in FY19

A. Mission Description and Budget Item Justification

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

Research is funded in six projects.

Project 869 refines knowledge and technologies on screening tools and preventive measures for post-traumatic stress disorder (PTSD) and mild traumatic brain injuries, physiological monitors, and interventions to protect Warfighters from injuries resulting from operational stress, and exposure to hazardous environments and materials. Also conducts research on medically valid testing devices (i.e., the test mannequins that are true to the human form and physiologically and anatomically accurate) and predictive models used for the refinement of Warfighter protective equipment. This project is being coordinated with the Defense Health Agency.

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army	Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army* / BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*

Project 870 designs and refines drugs, vaccines, medical diagnostic assays/tests devices, other preventive measures for protection and treatment against naturally occurring infectious diseases as identified by worldwide medical surveillance and military threat analysis. This project is being coordinated with the Defense Health Agency.

Project 874 identifies and evaluates drugs, biologics (medical products derived from living organisms), medical devices, and diagnostics for field trauma care systems, resuscitation, and life support, and post-evacuation restorative and rehabilitative care. Focus is identifying more effective critical care technologies and clinical practice guidelines to treat severe bleeding, traumatic brain injury, burns and other combat related traumatic injuries, and treatments for ocular (eye) injury and visual system dysfunction. Additional focus areas are laboratory and animal studies of regenerating skin, muscle, nerves, vascular and bone tissue for the care and treatment of wounded Service Members. This project is being coordinated with the Defense Health Agency.

Project ET4 identifies and evaluates drugs, biologics, medical devices, treatments and diagnostics for post-evacuation restorative, regenerative and rehabilitative care, as well as systems for use by field medics and surgeons for ocular trauma. Research focus is on identifying more effective technologies and protocols to treat ocular injury and visual system dysfunction, as well as laboratory and animal studies for regenerating skin, muscle, nerves, vascular and bone tissues for the care and treatment of wounded Service Members. This project is coordinated with the Defense Health Agency.

Project VB4 includes applied research in systems biology to provide a highly effective mechanism to integrate biological tests and computer simulations in clinical trials and in animal studies. The PTSD and coagulopathy exemplars have demonstrated the power of an iterative systems biology approach and are moving projects related to objective diagnostics and improved and personalized therapeutic strategies. Development of the SysBioCube (a data analysis, management and integration system) has provided the ability for complex collaborative efforts to share, process, and evaluate data using innovative technologies. These concerted refinement efforts using systems biology are showing reduction of time and funding for solutions to intractable problems of critical military importance.

Project XV5 conducts applied research on health information technologies that support combat casualty care under conditions of dispersed small-unit operations or requiring prolonged field care before evacuation. Technologies include autonomous casualty care systems and virtual health communications for Roles of Care one (combat medic and battalion aid station) through three (field hospital).

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

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

Exhibit R-2, RDT&E Budget Item Justification: PB 2019 Army	Date: February 2018
Appropriation/Budget Activity 2040: *Research, Development, Test & Evaluation, Army I* BA 2: *Applied Research*	**R-1 Program Element (Number/Name)** PE 0602787A *I Medical Technology*

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

Work funded in this PE is fully coordinated with efforts undertaken in PE 0603002A (Medical Advanced Technology) and the Defense Health Program.

B. Program Change Summary ($ in Millions)	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total
Previous President's Budget	77.111	83.434	88.575	-	88.575
Current President's Budget	78.341	83.434	90.075	-	90.075
Total Adjustments	1.230	0.000	1.500	-	1.500
• Congressional General Reductions	-	-			
• Congressional Directed Reductions	-	-			
• Congressional Rescissions	-	-			
• Congressional Adds	2.000	-			
• Congressional Directed Transfers	-	-			
• Reprogrammings	-	-			
• SBIR/STTR Transfer	-1.582	-			
• Adjustments to Budget Years	0.832	-	1.500	-	1.500
• FFRDC	-0.020	-	-	-	-

Congressional Add Details ($ in Millions, and Includes General Reductions)	FY 2017	FY 2018
Project: VB3: *MEDICAL TECHNOLOGY INITIATIVES (CA)*		
Congressional Add: *Military operational medical research program*	2.000	-
Congressional Add Subtotals for Project: VB3	2.000	-
Congressional Add Totals for all Projects	2.000	-

Change Summary Explanation

FY17 Congressional increase in VB3 Medical Technology Initiatives

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / *Medical Technology*	Project (Number/Name) 869 / *Warfighter Health Prot & Perf Stnds*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
869: *Warfighter Health Prot & Perf Stnds*	-	36.586	40.201	35.777	-	35.777	39.136	41.246	42.110	42.803	0.000	277.859

Note

Starting in Fiscal Year (FY) 2019 a number of efforts were consolidated into the four main thrust areas.

A. Mission Description and Budget Item Justification

This project conducts research to prevent and protect Warfighters from training and operational injuries, refine mechanisms for detection of physiological (human physical and biochemical function) and psychological (mental) health problems, evaluate hazards to head, neck, spine, eyes, and ears, set the standards for rapid return to duty, and determine new methods to sustain and enhance performance across the operational spectrum. This research provides medical information important to the design and operational use of military systems, and this work forms the basis for behavioral, training, pharmacological (drug actions), and nutritional interventions.
The four main areas of study are:

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

Additionally the Warfighter Systems Engineering Architecture task advances medical science and technology (S&T) in the areas of injury prevention and performance sustainment in the context of human interaction with new Soldier systems, and provides greater insight into informing new research in developing Warfighter systems and the interactions between Warfighters and the systems they employ.
Promising efforts identified in this project are further matured under PE 0603002A, project MM3.

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

Work in this project is performed by the US Army Aeromedical Research Laboratory (USAARL), Fort Rucker, AL; US Army Center for Environmental Health (USACEHR), Ft. Detrick, MD; US Army Institute of Surgical Research (USAISR), Joint Base San Antonio, TX; US Army Research Institute of Environmental Medicine (USARIEM), Natick, MA; Walter Reed Army Institute of Research (WRAIR), Silver Spring, MD; Naval Health Research Center (NHRC), San Diego, CA; and the Biotechnology High Performance Computing Software Institute (BHSAI), Frederick, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Physiological Health - Nutritional Sustainment and Fatigue Interventions	2.569	4.679	-

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 869 / *Warfighter Health Prot & Perf Stnds*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: This effort evaluates methods for managing and controlling the effects of fatigue on Warfighter operational performance and the impact of nutritional strategies to optimize operational performance. Starting in Fiscal Year (FY)19 this effort moves to Physiological Health. ***FY 2018 Plans:*** Conduct one or more field studies to determine the efficacy of energy and/or protein supplementation for preventing declines in lean body mass and cognition during and after caloric deficit (shortage of calories consumed). From the results of field studies, will continue to develop a descriptive model outlining factors linking the central nervous system and other organs/systems that impact resilience. Assess the effect of nutritionally optimized snack products for maintaining body composition and nutritional status during and after military training and operations in a field study. Develop interventions promoting resistance to physical, cognitive and environmental stressors. Evaluate the role of nutritional factors in the maintenance of physiological and neurobehavioral health under operationally relevant conditions. Analyze the effects of nutritional interventions on indicators of nutritional status. Demonstrate the effectiveness of nutrient and dietary strategies (e.g., omega-3 polyunsaturated fatty acids, zinc, and hydration) for reducing the vulnerability to and/or accelerating the recovery from mild TBI. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** In FY19, funding for Physiological Health - Nutritional Sustainment and Fatigue Interventions is reduced due to movement of funding for Nutrition & Weight Balance, Cognitive Health and Resilience, Nutrition to Accelerate Physiological Recovery Physical and Cognitive Readiness STO and Optimizing Mental Acuity STO to Physiological Health and Performance in order to reduce the number of R-Form Research Areas addressing Physiological Health.			
Title: Physiological Health and Performance	-	-	7.649
Description: This effort evaluates methods for managing and controlling the effects of fatigue on Soldier operational performance and the impact of nutritional strategies to optimize operational performance. Efforts will also contribute to human health and performance optimization and enhancement. ***FY 2019 Plans:*** Will develop nutritional interventions for resistance to stress (environmental/physical/cognitive) in the field. Will evaluate individual differences of environmental influences on Soldier eating behavior. Will improve the health of muscle and bone through characterization of protein source effects on metabolic kinetics. Will develop a military-specific eating questionnaire for evaluation of nutritional approaches to resist military stress. Will conduct studies to determine the effectiveness of energy and/or protein supplementation for preventing declines in lean body mass and cognition during and after caloric deficit. Will continue to develop a descriptive model outlining factors linking the central nervous system and other organs/systems that impact resilience. Will investigate physiological aspects of human health and performance optimization and enhancement. ***FY 2018 to FY 2019 Increase/Decrease Statement:***			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
FY19 funding for Physiological Health and Performance is available due to 1) movement of funding for Nutrition & Weight Balance, Cognitive Health and Resilience, Optimizing Mental Acuity STO, Nutrition to Accelerate Physiological Recovery Physical and Cognitive Readiness STO and Brain Health and Performance Risk is moved from Physiological Health - Nutritional Sustainment and Fatigue Interventions to Physiological Health and Performance to this task in order to reduce the number of R-Form Research Areas addressing Physiological Health and Performance; 2) increased funding for Nutrition & Weight Balance due to normal progression of the effort. reduced funding for Cognitive Health and Performance due to realignment of a sub-task to another CMI task and 3) reduced funding for Optimizing Mental Acuity due to normal progression and winding down of the effort as a result of realignment of funds in FY20 and beyond in support of new high priority programs and 4) reduced funding for Nutrition to Accelerate Physiological Recovery Physical and Cognitive Readiness STO due to planned progression of the effort and 5) increased funding for Brain Health & Performance Risk due to realignment of a sub-task from another CMI task and 6) increased funding for Biomedical Performance Enhancement due to normal progression of the effort and the fact that it became a new high priority program in FY18.			
Title: Concussion/Mild Traumatic Brain Injury (mTBI) Interventions	1.340	2.302	-
Description: This effort refines and evaluates methods to detect and treat concussion as well as identify and evaluate the effects of cognitive deficits (decreases in the ability of individuals to acquire knowledge and understanding through thought experience and the senses) and risk factors for spinal injury in Military vehicle occupants during operations. Starting in FY19 this effort moves to Injury Prevention and Reduction. ***FY 2018 Plans:*** Develop models of military vehicle occupant exposures that will be used for predicting cervical spine injury risk. Will collect exposure outcome data from the operational environments to improve provisional spinal injury criteria and assessment methods for occupant protection. Assess the effects of sleep duration, timing, and continuity of Mild Traumatic Brain Injury (mTBI) patients versus controls using actimetry sensors (non-invasive method of monitoring human activity/rest cycles) with the goal of determining differences in baseline sleep between mTBI patients, non-mTBI controls, and recovered mTBI controls in their home environments. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** In FY19, reduced funding for Concussion/Mild Traumatic Brain Injury (mTBI) Interventions is due to movement of funding for Blunt, Blast, & Accelerative Injury & Protection to Injury Prevention and Reduction in order to reduce the number of R-Form Research Areas addressing Injury Prevention and Reduction.			
Title: Environmental Health and Protection - Physiological (human physical and biochemical functions) Awareness Tools and Warrior Sustainment in Extreme Environments	1.351	1.380	-
Description: This effort evaluates the combined impact of extreme temperatures, humidity, and altitude on human health and performance and determines novel mitigation strategies to enhance tolerance, sustain performance, and protect the Warfighter			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
against environmental injury. This effort provides evidence-based practice recommendations, biomarkers of adaptation, and models for protecting health and performance against combinations of environmental threats. Starting in FY19 this effort is combined into Environmental Health and Protection. ***FY 2018 Plans:*** Evaluate the reliability, reproducibility, and validity of a novel militarily-relevant dexterity assessment instrument during cold- air exposures. Develop a low-power microclimate forearm heating prototype to maintain finger blood flow and hand dexterity during cold-air exposures. Determine the areas on the human that, when warmed, cause a physiological reflex response that increases finger blood flow and maintains manual dexterity in a cold environment. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** In FY19, funding for Environmental Health and Protection - Physiological (human physical and biochemical functions) Awareness Tools and Warrior Sustainment in Extreme Environments is reduced due to movement of funding for Heat, Cold & Terrestrial Altitude to Environmental Health & Protection in order to reduce the number of R-Form Research Areas addressing Environmental Health & Protection.			
Title: Environmental Health and Protection ***Description:*** This effort involves applied research addressing the physiological (human physical and biochemical functions) mechanisms of exposure to extreme heat, cold, altitude, and other environmental stressors. This effort establishes scientific evidence for specific and sensitive diagnostics of exertional heat illness to optimize Soldier performance in austere environments. This effort also supports and maturates non-invasive technologies, decision-aid tools, and models to enhance Soldier protection and sustainment across the operational spectrum. This effort provides the scientific basis for developing focused heating and cooling solutions to maintain fine motor dexterity, core temperature, and optimize physical and cognitive performance during cold-weather and hot-humid operations. This effort will develop knowledge and materiel solutions that enable Soldier individualized metabolic assessments and optimization during training and operations. ***FY 2019 Plans:*** Will determine the combined impact of heat, humidity, and high altitude on human health and performance. Will quantify Heat Tolerance Test specificity to include the effects of heat acclimation on the prediction of heat illness susceptibility and return to duty guidelines. Will quantify how physiological adaptations and acquired thermal tolerance to heat stress protect against acute mountain sickness susceptibility as well as physical and cognitive performance at high altitude. Will develop new technologies that enable quantitative measurements at a point-in-time during training and operational activities. Will increase dexterity performance in cold environments by combining facial and forearm microclimate heating interventions. Will develop computational models of individualized Soldier health, readiness, and physiological performance. ***FY 2018 to FY 2019 Increase/Decrease Statement:***	-	-	5.757

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
In FY19, funding for Environmental Health and Protection increased due to movement of funding from Physiological Awareness Tools and Warrior Sustainment in Extreme Environments: Heat, Cold & Terrestrial Altitude to Environmental Health & Protection in order to reduce the number of R-Form Research Areas addressing Environmental Health and Protection.			
Title: Biomarkers of Exposure and Environmental Biomonitoring (measurement of the body?s response to toxic chemical compounds, elements, or their metabolites, in biological substances) ***Description:*** This effort supports refinement and evaluation of methods to detect exposure to environmental contaminants and toxic chemicals during military operations. This effort develops an integrated experimental and computational platform to characterize host responses to environmental hazards in terms of pathogenic (disease causing) and adaptive processes, yielding mechanistically based drug targets and molecular diagnostics. Starting in FY19 this effort is combined into Environmental Health and Protection. ***FY 2018 Plans:*** Utilize an integrated experimental and computational platform to evaluate host responses to exposure (through the mouth, nose and skin) to environmental hazards (including toxic industrial chemicals [TICs] and metals such as chromium) in terms of pathogenic and adaptive processes. Develop several physiological-based dosimetery models of toxicity for TICs and heavy metals with adverse outcome pathways of liver, kidney, cardiac, and/or neural injury based on published and experimentally- derived data. Model output will guide small unit decision making through the generation of actionable health risk information that can predict the risk of adverse health effects in Warfighters with high sensitivity and specificity. Develop a methodology of evaluating central nervous system toxicity in order to determine sensitive and specific indicators of central nervous system injury. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** In FY19, reduced funding for Biomarkers of Exposure and Environmental Biomonitoring is due to: 1) movement of funding for Environmental Toxicant Exposure to Environmental Health and Protection; and 2) elimination of funding for the Environmental Toxicant Exposure STO in order to accelerate new high priority programs within MRMC.	5.249	4.889	-
Title: Injury Prevention and Reduction - Neurosensory Injury Prevention ***Description:*** This area includes research efforts to develop prevention based strategies and medically based injury criteria for hearing, vestibular (sensory system supporting movement and sense of balance, located in the inner ear), and ocular/facial protection devices, develop and evaluate neurosensory operational risk factors, develop medically based guidelines to assess neurosensory performance and model the effects of acoustic and impact trauma, as stressors on vision and hearing. Starting in FY19 this effort is combined into Injury Prevention and Reduction. ***FY 2018 Plans:*** Assess the complex interaction between auditory and vestibular protective systems. Validate blast exposure conditions that lead to cellular level ocular injury and continue to refine scaling laws to be able to relate experiments conducted in small animal	3.569	4.752	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
models to exposure conditions in humans, which will enable the development of computational models that can help predict the effects of the primary blast wave on the eyes and visual system in humans. Analyze potential neuroprotective (preserve nerve function) chemicals against primary blast injuries to the visual system. Evaluate provisional mandible blunt impact injury risk using two models (Facial and Ocular Countermeasures for Safety Headform (FOCUS) and Post Mortem Human Subjects (PMHS) to improve standards requirements for Warfighter protective gear. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** In FY19, reduced funding for Injury Prevention and Reduction - Neurosensory Injury Prevention is due to: 1) elimination of funding for Sensory Performance, Injury & Protection in order to accelerate new priority programs within MRMC; 2) movement of funding for Aircrew Health and Performance to the Injury Prevention and Reduction in order to reduce the number of R-Form Research Areas addressing Injury Prevention and Reduction.			
Title: Injury Prevention and Reduction - Musculoskeletal Injury Prevention ***Description:*** This effort evaluates and assesses the effects of repetitive motion during military operations and training on the human body; provides mathematical models to predict the likelihood of physical injuries following continuous operations and muscle fatigue; evaluates current standards for return-to-duty; and establishes improved medical test methods with the goal of rapid return to duty of Warfighters following injury. Starting in FY19 this effort is combined into Injury Prevention and Reduction. ***FY 2018 Plans:*** Consolidate results from animal- and human-based studies to refine the roles of endocrine (i.e., hormonal) and intracellular (i.e., within the cell) signaling molecules that are involved in skeletal muscle and bone development, utilizing animal and human models for transition to clinical trials. Refine a mathematical model of ideal bone density and structure that offsets risk of stress fracture. Utilize the Total Army injury and Health Outcomes Database (TAIHOD) to evaluate situations that create unnecessary musculoskeletal risk-hazards, and provide recommendations for mitigation. Analyze incidence and risk factors during the last 10 years for spinal injury in military personnel. Study the military vehicle occupant environment for the development of vibration health hazard assessment models. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Reduced funding for Injury Prevention and Reduction - Musculoskeletal Injury Prevention is due to movement of funding for Musculoskeletal Injury to Injury Prevention & Reduction in order to reduce the number of R-Form Research Areas addressing Injury Prevention & Reduction.	4.594	3.248	-
Title: Injury Prevention and Reduction ***Description:*** This effort addresses the Army?s number one priority of readiness by improving musculoskeletal injury prevention efforts as well as contributing to preparing Soldiers for potential threats (e.g., directed energy) in and developing capabilities for the multi domain battle environment; evaluates and assesses the effects of repetitive motion during military operations and	-	-	11.258

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
training on the human body; provides mathematical models to predict the likelihood of physical injuries following continuous operations and muscle fatigue; evaluates current standards for return-to-duty; and establishes improved medical test methods with the goal of rapid return to duty of Soldiers following injury. This effort also develops prevention based strategies and medically based injury criteria for hearing, vestibular (sensory system supporting movement and sense of balance, located in the inner ear), and ocular/facial protection devices, develops and evaluates neurosensory operational risk factors, develops medically based guidelines to assess neurosensory performance and models the effects of acoustic and impact trauma, as stressors on vision and hearing. Efforts will investigate the medical aspects of manned/unmanned teaming (MUM-T) and medical aspects of and protection against directed energy. ***FY 2019 Plans:*** Will develop injury criteria for the prevention of acute and chronic cervical neck injury and pain that will guide the development of helmets and technologies added to the helmet. Will develop mTBI injury thresholds for repetitive blast exposure that can guide the development of head protection. Will refine physical performance thresholds for potential improvements to the Occupational Physical Assessment Test (OPAT) which will improve how well recruits are screened to do DoD relevant physically demanding tasks. Will develop countermeasures to reduce the risk of overuse injury within the training and operational environment. Will identify cognitive and sensory performance metrics associated with optimal manned/unmanned teaming (MUM-T) and identify physiological and behavioral fitness for duty metrics to operate in MUM-T paradigms. Will develop medical standards and health hazard assessment algorithms for exposure to directed energy threats. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** In FY19, funding for Injury Prevention and Reduction is available due to: 1) movement of funding from Musculoskeletal Injury, Aircrew Health and Performance and Blunt, Blast, & Accelerative Injury to this task; 2) increased funding for Musculoskeletal Injury due to normal progression of the effort and high priority of the task; 3) eliminated funding for Sensory Performance, Injury & Protection to accelerate new priority programs within MRMC; 4) movement of funding from Aircrew Health & Protection to MM3 funding to support normal progression of task; 5) reduced funding for Blunt, Blast, & Accelerative Injury due to realignment of subtask to another CMI task; 6) increased funding for Medical Aspects of Man-Machine Teaming (MUM-T) due to normal progression of the effort and the fact that it became a new high priority program in FY18; and 7) increased funding for Directed Energy Health Hazard Assessment due to normal progression of the effort and the fact that it became a new high priority program in FY18.			
Title: Psychological Health - Psychological Resilience	6.403	8.467	-
Description: This effort refines and evaluates early interventions to prevent and reduce combat-related behavioral health problems, including symptoms of post-traumatic stress disorder (PTSD), depression, anger problems, anxiety, substance abuse, post-concussive symptoms, and other health risk behaviors. Also assesses and refines tools and interventions to enhance and			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
sustain psychological resilience throughout the Warfighter's career. Starting in FY19 this effort moves to Psychological Health and Resilience. ***FY 2018 Plans:*** Determine if a diet formulated with a balanced omega-3/6 fatty acids ratio, glutamine, and antioxidants provides enhanced resiliency against psychological stressors in humans. Evaluate the effects of novel compounds active in the glucocorticoid system (steroid hormones that are essential for the utilization of carbohydrate, fat and protein by the body and for the normal response to stress) and the endocannabinoid system (brain receptors that are involved in various physiological processes including appetite, pain sensation, mood and memory) for their ability to mitigate the adverse behavioral effects of traumatic stress and traumatic conditioning processes. Evaluate at least one drug candidate modulating the activity of orexin/hypocretin (a peptide found in the nervous system that regulates arousal, wakefulness and appetite) for its ability to mitigate the adverse behavioral effects of traumatic stress and traumatic conditioning processes. Continue studies focused upon identification of PTSD subtypes, stage of disease progression, and development of associated biomarkers for use in the identification and development of matched risk-based prevention interventions and development of a precision medicine algorithm approach to PTSD treatment. Determine the influence of sleep history on the efficacy and durability of Attention Bias Modification Training (ABMT), which is a computerized treatment that involves retraining an individual?s interpretation of other?s facial expressions away from predisposed perceptions of hostility, shifting interpretations in the direction of neutrality, to reduce his or her level of anxiety. Conduct a study with Soldiers in an operational unit to determine the predictive validity of trial-by-trial attention bias analytics versus traditional measures. Develop and pilot an evidence-based, self-discipline education program that positively influences Soldier outcomes related to resilience and readiness through the development of adaptive self-control and emotion regulation. Develop and pilot emotion regulation leadership training modules for unit leaders. Develop and pilot an evidence-based, team-level intervention that positively influences Soldier outcomes related to behavioral health, resilience, and unit readiness through the regulation of small-team dynamics (e.g., group-affect). Develop and pilot an individual-to-tool matching paradigm that allows leaders to optimally tailor intervention strategies to precisely meet their personnel and operational health needs. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** In FY19, reduced funding for Concussion/Mild Traumatic Brain Injury (mTBI) Interventions is due to movement of funding for Blunt, Blast, & Accelerative Injury & Protection to Injury Prevention and Reduction in order to reduce the number of R-Form Research Areas addressing Injury Prevention and Reduction.			
Title: Psychological Health & Resilience - Suicide Prevention ***Description:*** This effort supports methods to identify and modify causative and preventive factors in military suicides. Starting in FY19 this effort moves to Psychological Health and Resilience. ***FY 2018 Plans:***	5.389	4.873	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Assess key high risk emotional and behavioral transition points to decrease suicide behaviors. Develop and refine guidelines and tools for leaders, which will include evidence-based recommendations for identifying and addressing difficulties with post-combat adjustment and military community transformation and a revised Unit Behavioral Health Needs Assessment tool with metrics from combat operations, non-combat operations, and garrison. Develop a non-contact screening tool that identifies Service members at-risk for suicidal behaviors. Evaluate a theory-based suicide screen and clinical decision-making tool that identifies at-risk Service members. Conduct studies to develop tools to decrease suicide behaviors during key transition points of Service Members careers. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** In FY19, reduced funding for Psychological Health & Resilience - Suicide Prevention is due to movement of funding for Behavioral Health, Wellness & Resilience to Psychological Health and Resilience in order to reduce the number of R-Form Task areas related to Psychological Health & Resilience.			
Title: Psychological Health and Resilience	-	-	11.113
Description: This effort refines and evaluates early interventions to prevent and reduce combat-related behavioral health problems, including symptoms of post-traumatic stress disorder (PTSD), depression, anger problems, anxiety, substance abuse, suicide, and other health risk behaviors. This effort assesses and refines tools and interventions to enhance and sustain psychological resilience throughout Soldiers? careers. Efforts also address the health and well-being of families. ***FY 2019 Plans:*** This effort will assess risk and resilience markers (e.g., moral injury) for male and female Soldiers? psychological and behavioral health; determine the optimal dosing of Attention Bias Modification Training, a computerized treatment that reduces anxiety. Will evaluate evidence-based individual (e.g., self-distancing education, emotion regulation leadership training) and team-level (e.g., regulation of small-team dynamics) interventions that positively influence behavioral health, resilience, and unit readiness. Will assess key high-risk emotional and behavioral transition points, develop a non-contact screening tool and other interventions to decrease suicide behaviors. Will adapt and evaluate a diet formulated with a balanced omega-3/6 fatty acid ratio, glutamine, and antioxidants in an animal model for pilot study in humans in order to provide neuroprotection against military stressors. Will develop molecular pharmacological approaches and novel compounds to mitigate the adverse behavioral effects of traumatic stress. Will continue studies focused upon identification of PTSD subtypes, stage of disease progression, and development of associated biomarkers in order to develop a precision medicine approach to PTSD treatment. Will initiate studies for enhancing behavioral health treatment engagement, improving provider clinical support tools for return-to-duty decisions and identifying dissemination models for optimal behavioral health provider education. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** In FY19, funding for Psychological Health and Resilience is available due to: 1) movement of funding for Behavioral Health, Wellness & Resilience and Psychiatry & Clinical Psychology Disorders to this task in order to reduce the number of R-Form			

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Research Areas addressing Psychological Health and Resilience; 2) reduced funding for Behavioral Health, Wellness & Resilience due to realignment of a subtask to another CMI task; 2) reduced funding for Psychiatry & Clinical Psychology Disorders is reduced due to realignment of funds to new high priority programs within MRMC.			
Title: Millennium Cohort Research ***Description:*** This effort supports a long-term study of Warfighters that includes psychological and physical impacts of military service throughout their lifetime. The Millennium Cohort and Deployment Health Task area employs prospective epidemiological (study of health-event patterns in a society) surveillance research designed to address mental health and comorbid (multiple concurrent) disorders, including neurological and other chronic degenerative disorders, fitness and readiness performance outcomes, and longer-term physical and mental health illnesses and disease over the life cycle of military Service Members. ***FY 2018 Plans:*** Continue to evaluate the impact of military service on Warfighter and Family physical and psychological health. Specifically, will determine factors associated with persistent and long-term mental health and evaluate factors moderating or mediating associations between service-related experiences and mental disorders. Evaluate associations between behavioral health characteristics (e.g. physical activity, alcohol and tobacco use, and sleep hygiene) and short- and long-term outcomes among Service members and Veterans. Establish a program to investigate chronic disease risk among Service members and Veterans. Develop a program area focusing on environmental exposures experienced during deployments. Evaluate the representativeness and generalizability of the Millennium Cohort Family Study and initiate a study examining the impact of family relations on the Service member spouse. Develop a program area focusing on physical injury (traumatic and chronic) experienced during military service and mental health resilience, and establish agreements for access to objective data sources. Initiate processing of completed 2017-2018 paper surveys.. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Funding for Millennium Cohort Research was eliminated in FY19 to fund higher priority research in Medical Aspects of Man-Machine Teaming, Directed Energy Health Hazard Assessments, and Biomedical Performance Enhancement.	5.134	4.618	-
Title: Soldier Systems Engineering Architecture ***Description:*** This effort will advance medical science in the areas of injury prevention to optimize and sustain performance. This effort develops bio- mathematical models and networked physiological sensor systems that accurately predict metabolic cost, thermal strain and other negative health impacts to the Warfighter during physical challenges, i.e., during load carriage or operating in extreme environments. ***FY 2018 Plans:*** Evaluate newly developed bio-mathematical models, algorithms, and networked physiological sensor systems that accurately predict human metabolism rates, thermal strain and negative health impacts of Warfighters during physical challenges (i.e.,	0.988	0.993	-

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B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
complex operational scenarios in extreme environments). Computationally-intelligent network-capable sensors will have the ability to monitor and predict individual Warfighter physiological status (thermal, hydration, sleep status) in response to environmental conditions. Inform new research across the research and development community in the development of optimized systems and the interactions between Warfighters and the systems they employ. Leverage research in the Military Operational Medicine portfolio areas of Physiological Health and Protection, Injury Prevention and Reduction (both musculoskeletal and neurosensory), Psychological Health and Resilience and Environmental Health and Protection to inform the Warfighter Systems Engineering Architecture initiative. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** In FY19, reduced funding for Soldier Systems Engineering Architecture is due to: 1) movement of funding for Warfighter Physical Performance to Environmental Health & Protection in order to reduce the number of R-Form Research Areas addressing Environmental Health & Protection.			
Accomplishments/Planned Programs Subtotals	36.586	40.201	35.777

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

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COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
870: *Dod Med Def Ag Inf Dis*	-	20.841	22.234	21.651	-	21.651	22.081	19.405	19.813	20.209	0.000	146.234

Note

Diagnostics Systems funding ends in FY18 and the remaining FY19 funds are for Vector Identification and Control.

A. Mission Description and Budget Item Justification

This Project conducts applied research for medical countermeasures to naturally occurring infectious diseases that pose a significant threat to the operational effectiveness of forces deployed outside the United States. Effective preventive countermeasures (protective/therapeutic drugs and vaccines and insect repellents and traps) protect the Force from disease and sustain operations by avoiding the need for evacuations from the theater of operations. Diseases of military importance are malaria, bacterial diarrhea, and viral diseases (e.g., dengue fever and hantavirus). In addition to countermeasures, this project funds refinement of improved diagnostic tools to facilitate early identification of infectious disease threats in an operational environment, informing Commanders of the need to institute preventive actions and improve medical care. Major goals are to integrate genomics (deoxyribonucleic acid (DNA)-based) and proteomics (protein-based) as well as other new biotechnologies into the refinement of new concepts for new vaccine, drug, and diagnostics candidates.

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

(1) Prevention/Treatment of Parasitic (organisms living in or on another organisms) Diseases
(2) Bacterial Disease Threats (diseases caused by bacteria)
(3) Viral Disease Threats (diseases caused by viruses)
(4) Diagnostic Systems and Vector Identification and Control

For the refinement of drugs and biological products, studies in the laboratory and in animal models provide a proof-of-concept for these candidate products, including safety, toxicity (degree to which a substance can damage an organism), and effectiveness, and are necessary to provide evidence to the Food and Drug Administration (FDA) to justify approval for a product to enter into future human subject testing. Additional non-clinical studies are often needed in applied research even after candidate products enter into human testing during advanced technology development, usually at the direction of the FDA, to assess potential safety issues. Drug and vaccine refinement bears high technical risk. Of those candidates identified as promising in initial screens, the vast majority are eliminated after additional safety, toxicity, and/or effectiveness testing. Similarly, vaccine candidates have a high failure rate, because animal testing may not be a good predictor of human response, and therefore candidate technologies/products are often eliminated after going into human trials. Because of this high failure rate, a continuing effort to identify other potential candidates to sustain a working pipeline of countermeasures is critical for replacing those products that fail in testing.

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

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

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

Work in this Project is performed by the Walter Reed Army Institute of Research (WRAIR), Silver Spring, MD, and its overseas laboratories; the United States (U.S.) Army Medical Research Institute of Infectious Disease (USAMRIID), Fort Detrick, MD; and the NMRC, Silver Spring, MD, and its overseas laboratories.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Applied Research on drugs and vaccines against parasitic diseases	10.122	11.902	10.086

Description: This effort assesses and improves on candidate drugs coming from the Department of Defense (DoD) discovery program and from other collaborations for prevention and treatment of malaria; to counter the continuing spread of drug resistance to current drugs; assesses currently available drugs for use against cutaneous leishmaniasis (a skin-based disease transmitted by sand flies) in animal models; and select the most effective and safe candidates for continued refinement and possible clinical testing. This effort also conducts studies to investigate new candidate vaccines for preventing malaria and selects the best candidate(s) for continued refinement. A highly effective vaccine would reduce or eliminate the use of anti-malarial drugs and would minimize the progression and impact of drug resistance to current/future drugs.

FY 2018 Plans:
Continue studies in validated animal models to test reformulated chemical compounds for safety and efficacy against malarias. Continue assessment of pyramidinlyguanidine compounds (a newly discovered family of similar chemical compounds that are active against malaria parasites in experimental animals) for the treatment of malaria. Continue assessment of primaquine-like compounds (Primaquine is an FDA-licensed drug capable of preventing relapsing malaria) for use in treatment of relapsing malarias in the monkey model. Complete safety testing in validated animal models in order to test reformulated and down-selected vaccines against falciparum malaria (the most lethal of four types of malaria species). Continue to evaluate new vaccine candidates against vivax malaria (the most common of four types of malaria species) in small animals.

FY 2019 Plans:
Will complete studies in validated animal models to test reformulated triazine lead compound for safety and the dissemination in blood and tissues. These studies are required by FDA to enable oral dosing studies in humans. Will complete testing of pyrimidinylguanidine (a newly discovered family of similar chemical compounds that are active against malaria parasites in experimental animals) and primaquine-like compounds in primate malarias to enable initial human testing. Will complete laboratory based analyses of human immune cells from Plasmodium falciparum malaria vaccine trials to enable down selection of a lead vaccine for transition to advanced development. Will conduct initial effectiveness trials of potential lead vaccine formulations in primate models of a relapsing malaria, Plasmodium vivax.

FY 2018 to FY 2019 Increase/Decrease Statement:

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 870 / *Dod Med Def Ag Inf Dis*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Decrease due to economic adjustment.			
Title: Diagnostic Systems and Vector Identification and Control	1.358	1.438	0.524
Description: This effort designs and prototypes new medical diagnostic and surveillance tools for the field, focusing on bedside and field-deployable diagnostic systems and refines interventions that protect Warfighters from biting insects such as sand flies (transmitters of leishmaniasis) and mosquitoes (transmitters of dengue, Japanese encephalitis, malaria, etc.). Note: Diagnostics Systems funding will end in Fiscal Year (FY) 2018. ***FY 2018 Plans:*** Develop new vector repellant and control methods. Confirm spatial repellent efficacy testing protocols and systems that enable testing and development of best candidates for military use. Advance the capability for fabrics treated with repellants to protect or resist against biting insects and other arthropod vectors. Develop the multiplexed pathogen detection systems (capable of detecting multiple pathogens at the same time) that are cost effective, sustainable and usable to screen for priority emerging or re-emerging pathogens. ***FY 2019 Plans:*** Will further develop and evaluate the capability for fabrics treated with repellants to protect or resist against biting insects and other arthropod vectors. Will continue to evaluate multiplexed pathogen detection systems (capable of detecting multiple pathogens at the same time) to screen for priority emerging or re-emerging pathogens. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** A change in the priority of the effort. The civilian market is driving much of the innovation in this area of diagnostic research. As such, it is cost effective to let the market develop diagnostic platforms and the DoD develop the military relevant test menu of assays. This approach was successful with the BioFire FilmArray (Next Generation Diagnostic System). While a dedicated diagnostic capability will be eliminated within the Military Infectious Diseases Research Program, many of the existing task areas have the knowledge and proficiency to develop diagnostic assays.			
Title: Viral Threats Research	3.685	3.319	4.852
Description: This effort designs and laboratory tests new vaccine candidates against hemorrhagic fever viruses, i.e. Dengue Virus, Hantaviruses Lassa fever Virus and Crimean-Congo hemorrhagic fever virus, and assesses other non-vaccine technologies to protect against hemorrhagic fever viruses. Efforts also include establishing and maintaining of clinical trial sites worldwide. ***FY 2018 Plans:*** Expand vaccine test site infrastructure in selected communities at risk for dengue virus exposure and support research partner efforts in testing dengue vaccine immunogenicity (ability to provoke an immune response) and effectiveness. Continue to assess new vaccine formulations for safety and immunogenicity. Further develop additional DNA vaccines and combination vaccines against viruses of interest, e.g. Crimean Congo Hemorrhagic Fever. Explore multi-agent (combination of two or more molecules			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 870 / *Dod Med Def Ag Inf Dis*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
capable of inducing an immune response) vaccine concepts e.g., pan-hantavirus vaccine, Rift Valley Fever, Crimean Congo Hemorrhagic Fever vaccine. Develop an animal model of disease to test drugs and vaccines for protection against Hantavirus. ***FY 2019 Plans:*** Will sustain field sites as part of ongoing research partner efforts in testing dengue vaccine immunogenicity (ability to provoke an immune response) and effectiveness. Will conduct immune cell and antibody assessments in human subjects exposed to dengue by dengue human infection model. Will conduct immune cell and antibody assessments in human subjects immunized with purified inactivated virus and live attenuated virus vaccines. Will explore multi-agent (combination of two or more molecules capable of inducing an immune response) vaccine concepts e.g., pan-hantavirus vaccine, Rift Valley Fever, Crimean Congo Hemorrhagic Fever vaccine. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Increase due to economic adjustment.			
Title: Bacterial Threats ***Description:*** This effort conducts studies to refine bacterial countermeasures, including vaccine candidates, to prevent diarrhea (most commonly caused by enterotoxigenic E. coli, Campylobacter and Shigella), wound infection and scrub typhus (a debilitating mite-borne disease). ***FY 2018 Plans:*** Continue with the development of additional vaccine candidates against Shigella, Campylobacter and enterotoxigenic E.coli. Down-select vaccine candidates for further testing in animal models of diarrhea caused by Shigella, Campylobacter and enterotoxigenic E.coli. Continue to test the feasibility of clinical field sites for evaluation of vaccine candidates. Conduct studies on mechanisms of immune response to scrub typhus infection. Maintain an animal model for scrub typhus and will characterize host-pathogen interactions in animal models. ***FY 2019 Plans:*** Will continue to develop and advance additional vaccine candidates against Shigella, Campylobacter and enterotoxigenic E. coli (ETEC). Will continue to down select vaccine candidates for testing in animal models of diarrhea caused by Shigella, Campylobacter and ETEC. Will perform an assessment of multivalent (different types) vaccine candidates for Shigella and ETEC in animal models of diarrhea. Will produce vaccine candidates for testing in humans using Good Manufacturing Processes. Will continue to evaluate the feasibility of clinical field sites for the assessment of vaccine candidates in humans. Will continue to maintain the animal model for scrub typhus infection and will continue studies on characterization of host-pathogen interactions in these animal models. ***FY 2018 to FY 2019 Increase/Decrease Statement:***	5.676	5.575	6.189

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 870 / *Dod Med Def Ag Inf Dis*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Increase due to economic adjustment.			
Accomplishments/Planned Programs Subtotals	20.841	22.234	21.651

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / *Medical Technology*	Project (Number/Name) 874 / *Cbt Casualty Care Tech*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
874: *Cbt Casualty Care Tech*	-	9.849	11.127	12.781	-	12.781	14.944	15.063	15.431	15.615	0.000	94.810

A. Mission Description and Budget Item Justification

This project refines and assesses concepts, techniques, and materiel that improve survivability and ensure improved treatment outcomes for Warfighters wounded during combat operations, as well as treatment under austere field conditions. Combat casualty care research addresses control of severe bleeding, resuscitation and stabilization, predictive indicators and decision support technologies for life support systems, treatment of burns, and traumatic injuries to hard and soft tissues of the face, mouth, and extremities and traumatic brain injury (TBI).
This project is coordinated with the Military Departments and other government organizations to avoid duplication.
Research conducted in this project focuses on Combat Casualty Care Research in the following four areas:

(1) Damage Control Resuscitation
(2) Combat Trauma Therapies
(3) Combat Critical Care Engineering
(4) Traumatic Brain Injury

All drugs, biological products, and medical devices are refined in accordance with US Food and Drug Administration (FDA) regulations, which govern testing in animals to assess safety, toxicity, and effectiveness and subsequent human subject clinical trials.
Promising efforts identified in this project are further matured under Program Element (PE) 0603002A, Project 840.
The cited work is consistent with the Assistant Secretary of Defense, Research and Engineering Science and Technology, focus areas and the Army Modernization Strategy.

Work on this project is performed by US Army Institute of Surgical Research (USAISR), Joint Base San Antonio, TX, and the Walter Reed Army Institute of Research (WRAIR), Silver Spring, MD.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Damage Control Resuscitation	4.026	4.234	4.822
Description: This effort develops and refines knowledge products (such as clinical practice guidelines, manuals, protocols, studies, and media), materials, and systems for control of internal bleeding; minimizing the effects of traumatic blood loss; preserving, storing, and transporting blood and blood products; and resuscitation following trauma.			
FY 2018 Plans: Conduct studies to optimize performance metrics and assays of stem cells for treatment of trauma- or infection- induced impairment of blood clotting ability. Develop sensor technology for early assessment of blood clot strength. Evaluate novel products and approaches, including aortic balloon occlusion, automatically operated tourniquets, and new wound packing			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 874 / *Cbt Casualty Care Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
materials, to treat bleeding from chest, abdomen, arm pit and groin wounds and large, soft tissue wounds. Work to investigate drugs and key molecular components of blood required to optimize low volume resuscitation adjuncts to control bleeding and stabilize tissues in the pre-hospital phase of care. ***FY 2019 Plans:*** Will begin study of new techniques to control bleeding using catheters or other devices that are introduced into damaged blood vessels. Will conduct studies of new hemostatic (stops bleeding) dressings to determine if they may be safely left in place on wounds to control bleeding for extended periods of time. Will start a new research focus area on endovascular (refers to device that is directly introduced into a major blood vessel) hemorrhage control and resuscitation. Will continue studies to optimize performance metrics and assays of stem cells for treatment of trauma- or infection-induced impairment of blood clotting ability. Will continue development of new technologies for early assessment of blood clot strength. Will continue work to investigate drugs and blood products to optimize treatment of impaired blood clotting and destabilized tissues due to traumatic bleeding. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** This research area was expanded to include new research on endovascular hemorrhage control technologies. This new applied research work was originally planned to begin in Fiscal Year (FY) 2019; however, funds became available in FY18 to accelerate the effort. Project 874 funding for the Battlefield Platelets STO ended in FY18.			
Title: Combat Trauma Therapies ***Description:*** This effort conducts research to enhance the ability to diagnose, stabilize, and accelerate wound healing and repair of damaged tissue for casualties with severe wounds to the face, mouth and extremities. ***FY 2018 Plans:*** Develop preclinical wound model to examine effect of various resuscitation strategies (e.g., fluids, timing, volume) on healing of injured muscle and bone. Continue work from FY17 to develop and test combined agents (containing agents to kill bacteria, prevent bacteria from becoming infective, and to control inflammation) to treat contaminated facial, mouth and extremity wounds. ***FY 2019 Plans:*** Will conduct animal studies to assess adverse effects of inflammation factors released in response to blast injury. Will examine potential treatments to mitigate adverse effects of hemorrhage resuscitation on severe extremity wounds. Will evaluate stem cell therapy and drugs to promote healing in severe extremity injuries. Will continue development and testing of combined agents (containing agents to kill bacteria, prevent bacteria from becoming infective, and to control inflammation) to treat contaminated facial, mouth and extremity wounds. ***FY 2018 to FY 2019 Increase/Decrease Statement:***	2.539	3.374	2.567

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 874 / *Cbt Casualty Care Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Planned decrease in Project 874 funding for Combat Trauma Therapies research area as elements of the work mature towards Project 840 funding for advanced technology development and clinical evaluation.			
Title: Combat Critical Care Engineering ***Description:*** This effort refines diagnostic and therapeutic medical devices as well as associated algorithms, software, and data-processing systems for resuscitation, stabilization, life support, surgical support and preservation of vital organ function that can be applied across the pre-hospital, operational field setting, and initial definitive care facilities. ***FY 2018 Plans:*** Study means to mitigate risk of blood clot formation within the tubing of external life support devices (devices that oxygenate and purify the blood outside of the body) while at the same time allows normal blood clotting to occur in the patient. Continue work from FY17 to validate treatment algorithms in animal burn injury model. Continue work from FY17 to validate technologies to reduce preventable deaths due to difficult airway management. ***FY 2019 Plans:*** Will conduct animal studies to determine whether currently used pain-relieving drugs produce detrimental cardiovascular effects during hemorrhage resuscitation. Will study use of different stem cell products in animal models of lung injury. Will develop a small animal model of acute kidney injury caused by cessation of kidney blood flow due to severe, prolonged blood loss in which to assess new agents that protect the blood-deprived kidney. Will determine the whole-body effects of tourniquet release after prolonged use. Will design an automated, closed-loop burn and trauma resuscitation system that continuously monitors the patient's condition and automatically executes, without human intervention, an immediate and appropriate therapeutic response whenever the patient's condition deviates from normal. Will examine the ability of different critical care treatment algorithms to accurately detect and diagnose changes in patient condition and elicit an appropriate therapeutic response. Will develop and evaluate new technologies that will enable combat medics to provide basic critical care in out-of-hospital settings when medical evacuation is either delayed or prolonged. Will continue work to mitigate risk of blood clot formation within the tubing of external life support devices (devices that oxygenate and purify the blood outside of the body) while at the same time allow normal blood clotting to occur in the patient. Will continue work to assess physiological responses to airway compromise and to test new airway management techniques. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Planned increase in Project 874 funding for Combat Critical Care Engineering research area as elements of the work mature towards Project 840 funding for advanced technology development and clinical evaluation.	1.371	1.476	2.628
Title: Traumatic Brain Injury	1.913	2.043	1.361

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 874 / *Cbt Casualty Care Tech*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: This effort supports refinement of drug (includes mature drug technologies; Food and Drug Administration [FDA] approved for other indications) and therapeutic (i.e. novel use of stem cells or selective brain cooling) strategies to manage traumatic brain injury (TBI) resulting from battlefield trauma. ***FY 2018 Plans:*** Use data from neuroplasticity (ability of the nervous system to adapt to injury) marker studies to refine current animal models of military relevant brain injury to support studies of TBI treatments that work by affecting the injured brain?s ability to use energy and repair itself. Refine animal models of acute, severe TBI in combination with severe bleeding and lung and other vital organ injuries for evaluation of neurotherapeutic (therapies to protect brain tissue from further damage following a TBI event) resuscitation strategies for treatment of TBI and hemorrhagic (bleeding) shock. ***FY 2019 Plans:*** Will evaluate mild TBI treatment strategies using animal models. Will evaluate potential stem cell therapies in a severe TBI animal model. Will complete development of large animal models of TBI and TBI-polytrauma (TBI in combination with severe bleeding and lung and other vital organ injuries). Will perform studies to determine which biomarkers effectively indicate whether a particular therapy works and recovery is occurring. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** There is a planned decrease in Project 874 funding for Traumatic Brain Injury research as elements of the work mature towards Project 840 funding for clinical evaluation.			
Title: Prolonged Field Care ***Description:*** This effort performs applied research to study the physiological implications of delayed medical evacuation and limited access to definitive surgical care in severely injured casualties ***FY 2019 Plans:*** This is a new effort originally planned to begin in FY19; however, funds became available in FY18 to accelerate the work. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** This is a new start for FY19. There is a planned reduction in Project 874 funding for this area in FY19 as supportive Project S14 funded efforts begin (Project S14 funding for this new area does not begin until FY19). The Project S14 funded research will be necessary to support further advancement in the Project 874 funded research in this new research area.	-	-	1.403
Accomplishments/Planned Programs Subtotals	9.849	11.127	12.781

C. Other Program Funding Summary ($ in Millions)

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** 874 / *Cbt Casualty Care Tech*

C. Other Program Funding Summary ($ in Millions)

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / *Medical Technology*	Project (Number/Name) ET4 / *Appl Resch in Clinical and Rehabilitative Medicine*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
ET4: *Appl Resch in Clinical and Rehabilitative Medicine*	-	6.993	7.871	12.138	-	12.138	7.133	6.392	6.402	6.241	0.000	53.170

Note

The Battlefield Pain Management effort begins in FY19.

A. Mission Description and Budget Item Justification

This Project identifies and evaluates drugs, biologics (products derived from living organisms), medical devices, treatments and diagnostics for post-evacuation restorative, regenerative and rehabilitative care, as well as systems for use by field medics and surgeons for ocular trauma. Research focus is on identifying more effective technologies and protocols to treat ocular injury and visual system dysfunction, as well as laboratory and animal studies for regenerating skin, muscle, nerves, vascular and bone tissues for the care and treatment of traumatic injury. This Project is being coordinated with the Defense Health Program. Research involves extensive collaboration with multiple academic institutions to refine treatments for combat wounds through Armed Forces Institute of Regenerative Medicine (AFIRM). This Project is coordinated with the Military Departments and other government organizations to avoid duplication. Research conducted in this Project focuses on Clinical and Rehabilitative Medicine.

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

Promising efforts identified in this project are further matured under Program Element (PE) 0603002A, Project ET5.

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

Work on this Project is performed by United States Army Institute of Surgical Research (USAISR), Joint Base San Antonio, TX; and the AFIRM, at Multiple Institutions across the United States.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Clinical and Rehabilitative Medicine	6.993	7.871	9.439
Description: This effort conducts laboratory and animal studies for the purpose of regenerating and restoring traumatically-injured tissues, including skin, muscle, nerve, bone tissue, and the ocular system. This research moved from Project 874 to Project ET4 starting in FY17.			
FY 2018 Plans:			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** ET4 / *Appl Resch in Clinical and Rehabilitative Medicine*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Optimize preclinical design of a novel ocular medical device designed to deliver therapeutics, protect, and preserve vision post-injury. Establish the effects of treatment of up to three promising pharmaceuticals designed to restore vision in the scarred eye after injury for down selection. Conduct pre-clinical safety and efficacy testing of an eye bandage with therapeutics to optimize vision restoration post-injury. Evaluate methods for enhancing skin substitute performance for improvement of skin function following burns and loss from trauma. Examine pharmacologic (drug) treatments to prevent scarring from deep partial-thickness burns. Establish effectiveness of treatment methodologies for large volume muscle loss to restore muscle form and function. Develop devices and biologics for regeneration or restoration of genitourinary (genital and urinary) tissues lost or damaged due to traumatic injury. ***FY 2019 Plans:*** Will continue to optimize the preclinical design of a novel ocular medical device designed to deliver therapeutics, protect, and preserve vision post-injury. Will advance evaluations of stem-cell based therapies to regenerate damaged eye tissues into pre-clinical animal testing. Will utilize intra-eye large animal drug delivery system to deliver and evaluate effectiveness of nerve therapeutics to preserve and regenerate injured optic nerves. Will continue to conduct pre-clinical safety and effectiveness testing of an eye bandage with therapeutics to optimize vision restoration post-injury. Will continue to develop and evaluate methods for enhancing skin substitute performance for improvement of skin function following burns and loss from trauma. Will continue the examination of pharmacologic (drug) treatments to prevent scarring from deep partial-thickness burns. Will examine the effectiveness of treatment methodologies for large volume muscle loss to restore muscle form and function. Will continue to develop devices and biologics for regeneration or restoration of genitourinary (genital and urinary) tissues lost or damaged due to traumatic injury. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** Adjustment due to inflation for Regen and Sensory. New Task Area created for Battlefield Pain Management to accelerate research of several potential novel drugs for elimination of acute and battlefield pain.			
Title: Battlefield Pain Management	-	-	2.699
Description: This effort performs applied research in laboratory and animal studies to develop novel, non-opioid drugs to treat pain in the austere battlefield environment with minimal side effects. ***FY 2019 Plans:*** Will conduct animal studies to investigate the role of ion channel receptors and pain signaling; will develop peripheral nerve or antagonist analgesics to preserve the fighting force and maximize pain relief from combat wounds in austere and prolonged care environments while minimizing adverse side effects such as tolerance, dependence and chronification (occasional/intermittent pain that progresses to a chronic state) of acute pain. ***FY 2018 to FY 2019 Increase/Decrease Statement:***			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** ET4 / *Appl Resch in Clinical and Rehabilitative Medicine*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Accelerate research of several potential novel drugs for elimination of acute and battlefield pain.			
Accomplishments/Planned Programs Subtotals	6.993	7.871	12.138

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / *Medical Technology*	Project (Number/Name) VB3 / *MEDICAL TECHNOLOGY INITIATIVES (CA)*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
VB3: *MEDICAL TECHNOLOGY INITIATIVES (CA)*	-	2.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	0.000	2.000

Note

Congressional Increase

A. Mission Description and Budget Item Justification

Congressional Interest Item funding for Medical Technology applied research.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018
Congressional Add: Military operational medical research program	2.000	-
FY 2017 Accomplishments: N/A		
Congressional Adds Subtotals	2.000	-

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / *Medical Technology*	Project (Number/Name) VB4 / *System Biology And Network Science Technology*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
VB4: *System Biology And Network Science Technology*	-	2.072	2.001	2.008	-	2.008	2.050	2.099	2.143	2.187	0.000	14.560

A. Mission Description and Budget Item Justification

This Project supports biological and clinical applied research using the data analysis and integration grid (SysBioCube) as an overarching means of complex data usage to solve critical health problems. The primary capability of systems biology (field of study that focuses on complex interactions within biological systems, using a holistic approach) is the integration and analysis of complex human and animal study data and development of computational disease models, using global multi-omic methods to identify and discriminate unique combinations of biological molecules corresponding to clinical conditions (physiologic, immunologic, endocrine, etc.), supporting transition of research to clinical applications. This capability applies a systematic integrated approach to trace progression of illnesses and diseases and has already shown that the approach significantly reduces time, funds and effort invested in medical product development and refinement as seen in biomarker development for Post-Traumatic Stress Disorder (PTSD) and enhanced analyses of coagulopathy. Another application of systems biology is to characterize physiological pathways altered by toxic substances enabling identification of the causative toxic substances as well as to understand the injury mechanisms. The detection/identification of physiological markers of exposure to toxic substances can then be used to support medical countermeasure decisions or development of targeted therapeutic drugs.

These examples of more complex, yet integrated approaches to Projects studying biological systems (PTSD) Project have been shown to reduce both the time and expense of medical product development for the Army.

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

Work in this Project is performed by the United States Army Medical Research and Materiel Command (USAMRMC), Fort Detrick, MD / United States Army Center for Environmental Health Research (USACEHR).

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Systems Biology	2.072	2.001	2.008
Description: The core capability for multidisciplinary applied research in systems biology enables integration and analysis of complex data from human and animal studies and development of computational network models, allowing researchers to differentiate among molecular signatures (unique combinations of biological molecules corresponding to clinical conditions) of disease, and supports transition of research to clinical applications to diseases of military relevance. Applied research is being conducted to identify biological networks that are causative of illness in Post-Traumatic Stress Disorder (PTSD) and co-morbidities (presence of one or more diseases or disorders), coagulopathy (impaired ability to clot blood) of trauma, Traumatic Brain Injury,			

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** VB4 / *System Biology And Network Science Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019

pain, suicide, infectious disease, and immune responses. In particular, the studies of PTSD are directed to refine biomarkers for screening, early diagnosis and therapeutic target discovery.

FY 2018 Plans:

Expand Systems Biology capabilities, to facilitate collaborative intramural and extramural partnerships, and to accommodate an expected increase in the number of end-users of the SysBioCube (USAMRMC?s information management suite, hosted by the National Cancer Institute (NCI) / National Institutes of Health (NIH) via the Frederick National Laboratory for Cancer Research). Oversee data sharing and data integration of large, complex datasets. Increase capabilities to develop novel methods that integrate different systems biology data (e.g., genetics and metabolism data) that, in turn, lead to new knowledge products. Provide support to the Integrative Systems Biology Program at United States Army Center for Environmental Health Research (USACEHR) for oversight of research efforts. Time-dependent clinical data collections and integrated omics analyses of treatment efficacies to be used in a wide range of studies including biomarker development and the understanding the altered molecular mechanisms that underlie PTSD, coagulopathy (blood?s ability to form clot is impaired), chronic pain perception, infectious diseases, and micro-gravitational stress on bone. Build a data-repository capability within the SysBioCube that will initially be for publications and associated datasets from 6.1 (Basic Research)-funded intramural research.

FY 2019 Plans:

Will expand Systems Biology capabilities through collaborative intramural and extramural partnerships, and accommodate an expected increase in the number of end-users of the SysBioCube (USAMRMC?s information management suite, hosted by the National Cancer Institute (NCI)/National Institutes of Health (NIH) via the Frederick National Laboratory for Cancer Research (FNLCR)). Will expand the data repository capability within the SysBioCube. Will continue to oversee data sharing and data integration of large, complex datasets. Will continue to increase capabilities to develop novel methods that integrate different systems biology data (e.g., genetics, microbiome, and metabolism data) that, in turn, will lead to new knowledge products. Will continue to provide support to the Integrative Systems Biology Program at USACEHR for oversight of research efforts. Will continue development of SysBioCube capabilities and functions such as integration and harmonization of additional data types (variant level Next Generation Sequencing data), browse and filtering functions to search for and sort specific assay types and associated data, tracking of assays conducted, and additional tools for longitudinal analysis and visualization of integrated data. Will use time-dependent clinical data collections and integrated omics (omics refers to the collective technologies used to explore the roles, relationships, and actions of the various types of molecules that make up the cells of an organism) analyses of treatment efficacies to support a wide range of research efforts that will include additional biomarker development and understanding of the underlying altered molecular mechanisms of a) PTSD (including changes in the microbiome (gut microbes) and in metabolism) that will begin to correlate co-morbid (concurrent) conditions, and b) infectious diseases.

FY 2018 to FY 2019 Increase/Decrease Statement:

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** VB4 / *System Biology And Network Science Technology*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Starting in FY19, the effort for refinement and evaluation of methods to detect exposure to environmental contaminants and toxic chemicals during military operations is combined into Environmental Health and Protection of MOMRP. The remaining VB4 effort will have adjustment to inflation.			
Accomplishments/Planned Programs Subtotals	2.072	2.001	2.008

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army			Date: February 2018
Appropriation/Budget Activity 2040 / 2	R-1 Program Element (Number/Name) PE 0602787A / *Medical Technology*	Project (Number/Name) XV5 / *Medical Capabilities to Support Dispersed Operations*	

COST ($ in Millions)	Prior Years	FY 2017	FY 2018	FY 2019 Base	FY 2019 OCO	FY 2019 Total	FY 2020	FY 2021	FY 2022	FY 2023	Cost To Complete	Total Cost
XV5: *Medical Capabilities to Support Dispersed Operations*	-	0.000	0.000	5.720	-	5.720	9.364	9.623	10.142	10.376	0.000	45.225

Note

This is a new start in FY19.

A. Mission Description and Budget Item Justification

This Project line will support the following three new medical task areas: 1) Autonomous and Unmanned medical capability - will focus on developing the ability to deliver emergency resupply of CLVIII by ground or air, such as blood products, and, utilization of platforms to perform evacuations, 2) Virtual Health - will enable prolonged care and deciding faster by exploiting emerging communications and information technology for remote telemonitoring and telementoring, 3) Medical Aspects of man-machine teaming - will enable teaming to deliver medical care, and establish medical performance criteria to ensure Soldiers have the physiological, cognitive, and psychological capacity to perform man-machine teaming.

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Title: Autonomous and Unmanned Medical Capability	-	-	1.721
Description: Research, design, and prototype autonomous and unmanned capabilities to deliver high quality combat casualty care in dispersed operations with limited or absent medical care personnel in support of the Army Multi-Domain Battle concept and the Army Force 2025 and Beyond vision. ***FY 2019 Plans:*** Will utilize invasive and non-invasive sensor systems to define new models for human physiologic responses to injury. Data from these models will be used to define new algorithms that drive resuscitation and critical care procedures in animal models. Algorithms will be defined for implementation across a full spectrum of automation capabilities. Will define the physiological process associated with injury in trauma simulations that would be amenable to automated therapeutics with autonomous medical systems. Will explore feasibility of integrating medical capabilities and information systems with Army unmanned systems (UMS) Programs of Record in order to leverage multipurpose robotic platforms for medical capabilities. Will research standardization of medical device interfaces for use in an autonomous platform. Will research feasibility of Unmanned Aerial Systems (UAS) to support remote patient monitoring research prototypes, closed-loop patient support systems, and prototype automated diagnostic and therapeutic en route care capabilities. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The MCSDO program (XV5) is a new start in FY19.			
Title: Virtual Health	-	-	1.998

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** XV5 / *Medical Capabilities to Support Dispersed Operations*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
Description: To develop future Virtual Health enterprise process architectures and integrated physical solutions capable to supporting prolonged field care in conditions with limited or lacking traditional field communications. ***FY 2019 Plans:*** Will generate an overall Virtual Health technology research plan with detailed research tasks to support the Multi-Domain Battlefield Concept to include potential cross-domain with other research task areas. Will research and model novel Virtual Health enterprise process architectures to provide new intersections of health information and knowledge far forward to support the Multi-Domain Battlefield Concept. Will conduct a gap analysis of mechanisms for Virtual Health secure data transmission and communications in the tactical environment leveraging novel means to reduce virtual health encounter data packet sizes through novel compression algorithms to facilitate use in very limited communication scenarios to support the Multi-Domain Battlefield Concept. Will determine key physiological constructs that are predictive of health status and readiness for development of a micro-footprint biosensor-based assessment tools. ***FY 2018 to FY 2019 Increase/Decrease Statement:*** The MCSDO program (XV5) is a new start in FY19.			
Title: Medical Aspects of Man-Machine Teamining/Medical Robotics ***Description:*** Research, design, and prototype future medical robotic systems capable of providing autonomous combat casualty care while optimizing the medical logistic footprint in far-forward and dispersed geographic environments in support of the Army Multi-Domain Battle concept and the Army Force 2025 and Beyond vision. ***FY 2019 Plans:*** Will research the design of robotic systems, including physical interfaces and hardware configurations, to effectively implement and control resuscitation and critical care procedures driven by algorithms defined by complementary research described in the Autonomous and Unmanned Medical Capability Task Area. Will research and design a proof of concept field robotic fold-up litter to show the feasibility of deploying soft robotics sensors and also show the capability to apply pressure using a soft robotics manipulator. Will model and characterize the problems caused by signal latency and constrained bandwidth on complex tele-robotic surgical tasks. Will research and prioritize procedures amenable to full automation of tele-robotic operations. Will research and explore the feasibility of using robotic perception systems to detect casualties from a standoff distance and at closer ranges using both conventional computer vision approaches and recent advancements in deep learning techniques. Will research and prioritize procedures. ***FY 2018 to FY 2019 Increase/Decrease Statement:***	-	-	2.001

Exhibit R-2A, RDT&E Project Justification: PB 2019 Army		Date: February 2018
Appropriation/Budget Activity 2040 / 2	**R-1 Program Element (Number/Name)** PE 0602787A / *Medical Technology*	**Project (Number/Name)** XV5 / *Medical Capabilities to Support Dispersed Operations*

B. Accomplishments/Planned Programs ($ in Millions)	FY 2017	FY 2018	FY 2019
The MCSDO program (XV5) is a new start in FY19.			
Accomplishments/Planned Programs Subtotals	-	-	5.720

C. Other Program Funding Summary ($ in Millions)

N/A

Remarks

D. Acquisition Strategy

N/A

E. Performance Metrics

N/A